TECHNICAL MEMORANDA

CONTINGENCY ACTION PLAN FOR CALAVERAS DAM EVALUATIONS

Prepared for
Public Utilities Commission
City and County of San Francisco
1155 Market Street
San Francisco, CA 94103

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URS

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TABLE OF CONTENTS

SECTION 1

URS

Memorandum

Date: September 9, 2002

To: Patty Mallett, SFPUC

From: Noel Wong

Subject: *Calaveras Dam Evaluations – Contingency Action Plan*
Task 1 – Interim Operations (Peer Review)

This memorandum summarizes our comments developed as a result of our review of the following two reports prepared by Olivia Chen Consultants (OCC) for the SFPUC:

1. Calaveras Dam Seismic Stability Project Draft Report on Updated Dam Internal Geometry and Post-Earthquake Stability, February 13, 2002.

2. Draft Addendum Report: Calaveras Dam Seismic Stability Investigation, August 2002.

Our review was undertaken in accordance with the scope of work outlined in our proposal of March 27, 2002. The scope of our review, as stated in the proposal, was to conduct a peer review of the studies performed by OCC for determining the safe operating level for the reservoir that is acceptable to the California Division of Safety of Dams (DSOD), while the SFPUC pursues plans for the repair or replacement of the dam.

The comments presented herein have been prepared by Demetrious Koutsoftas and Noel Wong and reviewed by Lelio Mejia. The URS review focuses on the major factors affecting the stability of the dam and whether the studies completed so far can establish definitively the safe operating level of the reservoir. It is not intended to provide a comprehensive critical review of all of the data and analyses included in the report. In most instances, our comments and recommendations are intended for clarification of missing or inconsistent information and analyses that were conveyed in the reports. Our review comments address the following issues:

1. Dam zonation, classification and geotechnical characterization
2. Groundwater levels and seepage conditions
3. Geologic and earthquake ground motions studies
4. Evaluation of liquefaction potential
5. Anticipated performance of the dam during and after the design earthquake
6. Reservoir level for interim operations

Our comments on the above six issues are summarized below.

1. Dam zonation, classification and geotechnical characterization

The OCC study attempts to subdivide the dam into a large number of zones based on their understanding of the construction methods and sequence, and the results of the geotechnical explorations performed as part of the current study and the explorations performed previously by Wahler & Associates. The report states: *"At the main level, the zones were established genetically (based on origin or placement method), but the main zones were also divided into subzones with similar gradation characteristics."* There are

some major differences from the original zonation provided by W&A. The OCC report does not provide details as to the basis for the subdivision of the dam into 22 zones. Therefore, it is not possible for URS to evaluate the accuracy, or the appropriateness of such a detailed and somewhat intricate zonation of the dam.

The zonation itself may not be critical. However, in this case, the subdivisions proposed in the OCC report are significant to the stability of the dam because the residual undrained shear strengths assigned to these different layers are substantially different. Our comments on the selected strength properties are discussed below.

[redacted]

We understand that the measured penetration resistance values were corrected for the effects of overburden pressure, fines content, hammer energy ratio, rod length, sampling method, and gravel content. With the exception of the gravel content corrections, the procedures for the rest of the test parameters are standard and generally accepted in the profession. However, the fines content correction, as applied in this investigation, the gravel correction, and the use of the 30th percentile $N_{1(60)}$-values as applied in the report need to be justified and explained clearly in the report. Specifically,

- It is not clear from the report whether laboratory tests had been performed for each SPT or Becker test value to determine the appropriate fines content. It appears that some of the values used might have been estimated by visual inspection. Also, in cases when sample material was lost, the fines content values were modified to reflect the investigators' assumption that this material must have been granular, and the values were reduced to reflect a higher proportion of granular material in the sample. The report does not provide evidence to support the conclusion that the material not recovered was indeed granular. Without further explanation, the above corrections would appear to be subjective and potentially leading to overly conservative results. The report needs to clearly state the assumptions and potential for errors involved in the selection of fines content values, particularly if a significant number of data points had been corrected.

- The procedure used in the study for correcting for gravel content reduces high N-values that are assumed to have been affected by gravel, is not a well-established standard of practice, and the OCC report acknowledges that this is a conservative aspect of their evaluation. Additional explanation and justification for using this procedure is necessary.

- The report does not provide justification for using the 30th percentile of $N_{1(60)}$-value to estimate the residual shear strengths. Data from different depths within a zone are lumped together. We have identified instances where "weaker testing intervals" within a 120-foot thick zone end up dominating the residual shear strength estimation and the entire layer is assigned the same low strength. We also found some instances where N-values from clay and silt layers were lumped together with data for sands, and as such, unwarranted strength loss may have been assumed for these clay and silt layers. The report should explicitly justify these types of assumptions and should justify the use of

30th percentile of $N_{1(60)}$-values because these assumptions could be leading to overly conservative results.

2. Groundwater levels and seepage conditions

This is an important factor that affects the evaluation of liquefaction potential, as well as the stability analyses. The reports have not addressed this issue directly. The cross-sections presented in the reports show water levels at various borehole locations. But the seepage conditions and the interpretation of the water level measurements are not provided in the report.

The report prepared by Geomatrix Consultants (part of the Draft Addendum Report) indicates that the phreatic line was determined analytically by performing a seepage analysis using the computer program FLAC. We could not find any discussion of the comparison of the computed phreatic line with actual measurements of water levels.

It appears that new piezometers had been installed as part of the OCC investigation. Plots of piezometric levels are included in the addendum report. However there is no discussion or interpretation of the measurements.

It is our recommendation that the report should include a detailed discussion of water level measurements and an estimation of the location of the phreatic line along the maximum, east and west sections of the dam.

3. Geologic and earthquake ground motions studies

We understand that a reconnaissance-level geologic study of the Calaveras Dam site and an earthquake ground motions study have been completed as part the OCC study. The report prepared by Geomatrix (part of the Draft Addendum Report) also makes reference to a document that establishes the earthquake ground motions used in the numerical analyses. Obviously, the results of the geologic studies at the dam site, and the conclusions on faulting and proposed earthquake ground motions are important to the evaluation of the seismic stability and performance of the dam. As such, the results of these studies will need to be reviewed and approved by the DSOD. We recommend that the results of the geologic and earthquake ground motions studies be formally documented and incorporated in the current reports.

4. Evaluation of liquefaction potential

It appears that the OCC study has assumed that the materials that constitute the dam would liquefy. The report prepared by Geomatrix (part of the Draft Addendum Report) makes reference to liquefaction analyses performed by OCC. The results of the liquefaction analyses, however, were not included in the report.

We find that the results of the dynamic analyses presented in the Geomatrix report are not consistent with a conclusion that the materials in the dam will experience widespread liquefaction. In fact, their report indicates that the analyses suggest that liquefaction would not occur everywhere in the dam (additional discussion is provided in the following Section 5). If the results of the numerical analyses were not considered, an explanation should be provided.

Geophysical tests were performed at a number of borehole locations to estimate the shear wave velocities of the soils. The results of the geophysical tests were used by Geomatrix to estimate deformation parameters for the dynamic analysis, but it appears that they have not been considered in the characterization of major strata or liquefaction potential.

Our review finds that the shear wave velocity data actually correlate fairly well with the borehole data. In this regard, we note that there is a liquefaction evaluation procedure using shear wave velocity data developed by Andrus and Stokoe (2000), and that their liquefaction charts indicate that liquefaction is not likely for materials with normalized velocity values in excess of 200 m/sec.

We recommend that the liquefaction analyses performed by OCC and referenced by Geomatrix be included in the report. Given the available geophysical data, OCC should also determine if the liquefaction analyses need to be revised before any conclusions can be drawn as to the post-earthquake stability and deformations of the dam. If the geophysical data were not considered, an explanation should be provided.

5. Anticipated performance of the dam during and after the design earthquake

As we indicated above, the OCC study has assumed that the materials that constitute the dam would liquefy. The focus of the report was to estimate the residual shear strength of the various zones, so that a post-earthquake stability analysis could be performed.

Stability evaluations based on two-dimensional limit equilibrium models were carried out assuming critical zones in the dam were to liquefy. It is noted that the actual reservoir level assumed in the analyses was never stated directly in the main reports. Only the Geomatrix report indicated that *"a reservoir water level at elevation 710 feet"* was assumed. We recommend that the reservoir level used in all the analyses be clearly stated in USGS or CS Datum in the reports.

We were not surprised that when full liquefaction of the critical zones in the dam was assumed with the proposed residual shear strengths, the simplified analyses would calculate significant deformations with an estimated crest settlement of 60 feet. It is our understanding that the more detailed numerical analysis (using the computer program FLAC) was intended to confirm and refine the results of the simplified stability evaluation.

We do not consider the results of the pseudo-static deformation analysis using FLAC an independent confirmation of the dam's performance because the same assumptions of full liquefaction and residual strength of the critical zones have been made. The fact that the FLAC pseudo-static analysis also calculates about 60 feet of crest settlement only confirms the computer program's computing functions.

When Geomatrix used the dynamic, effective-stress analysis procedure in FLAC, they calculated and evaluated the dynamic response, the potential for liquefaction and the deformation of the dam. In this case, the computed deformations were significantly less and the estimated crest settlement was only about 11 feet. Geomatrix also reported that the results of the analyses indicated that *"although significant portions of the saturated zones within the embankment were predicated to liquefy, not all zones were found to liquefy"*, and that this finding *"differs from the assumption used in the pseudo-static analysis"*.

We, therefore, find that the results of the dynamic analyses presented in the Geomatrix report are not consistent with the assumption that the materials in the dam will experience widespread liquefaction.

We strongly recommend that additional discussions and justifications be provided with regard to the validity of the assumption that has been used in most of the study. Again, if the results of the dynamic analyses were not considered, an explanation should be provided.

6. Reservoir level for interim operations

It appears that all the analyses have been performed for a maximum "*temporary water level after winter storm*" of 710 feet USGS Datum. We did not find any discussion on how this particular reservoir level might have been established. It is unclear whether this reservoir level corresponds to the interim safe reservoir level that was established from the referenced OCC August 2001 evaluation. A discussion and clarification on the actual evaluation and recommendation of interim safe reservoir level is needed.

We trust the above comments will assist you in the preparation of the draft reports for submittal to the DSOD. We are also including copies of a few text pages and figures from the reports where minor clarifications or corrections might be needed. If you have any questions with our review or any of the above comments, please contact us.

SECTION 2

URS

Draft Memorandum

Date: August 9, 2002

To: Patty Mallett, SFPUC

From: Noel Wong

Subject: *Calaveras Dam Evaluations – Contingency Action Plan*
Task 2.1 – Remedial Alternatives Evaluation – Project Objectives

In accordance with the scope of work outlined in our proposal of March 27, 2002 (Exhibit 1), URS has worked jointly with the SFPUC team to develop two sets of draft Project Objectives consistent with two alternative reservoir storage scenarios:

- Repair or replacement of the existing dam for the same storage capacity; and
- Replacement of the existing dam for expanded reservoir storage capacity, or with provisions for future expansion.

This draft interim memorandum summarizes results of the project team's workshop on July 16 regarding project objectives. Since a broad range of project alternatives was also discussed during the workshop, the alternatives are also summarized herein. We have also included our initial assessments of the potential objectives and how well the preliminary range of project alternatives matches up with the project objectives. An interim memorandum, which will be distributed in late August, will discuss and evaluate the alternatives in more detail.

1. Potential Project Objectives

Based on the discussions during the team's workshop on July 16, we identified the following potential project objectives for the proposed repair or replacement of Calaveras Dam:

1. Mitigate public dam safety concerns
2. Restore pre-restriction water supply
3. Complete a project (or phase) to restore pre-restriction water supply as soon as possible
4. Complete the project with minimal environmental impacts
5. Complete the project most cost-effectively
6. Maintain pre-restriction water supply quality
7. Maintain pre-restriction recreation opportunities
8. Improve energy efficiency of reservoir operations
9. Enhance conveyance capacity to SVWTP
10. Change diversion from Alameda Creek
11. Augment pre-restriction water supply for increased operational reliability
12. Augment pre-restriction water supply for drought protection
13. Develop a regional project that provides water supply for other agencies as well as SFPUC

2. Preliminary Range of Alternatives

During the July 16 workshop, the team also discussed a broad range of project alternatives that could be considered. The two original scenarios as referenced in our proposal were: (1) repair or replacement of

the existing dam for the same storage capacity; and (2) replacement of the existing dam for expanded reservoir storage capacity, or provisions for future expansion. These were expanded to include the following range of alternatives:

1. Remove the unsafe dam and secure other sources of water supply.
2. Repair or replace with smaller dam and reservoir and secure other sources of water supply.
3. Repair or replace with same size dam and maintain diversion from Alameda Creek.
4. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek.
5. Repair or replace with smaller dam and reservoir and secure other sources of water supply while providing base for future enlargement.
6. Repair or replace with same size dam and reservoir and maintain diversion from Alameda Creek while providing base for future enlargement.
7. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek while providing base for future enlargement.
8. Repair or replace with larger dam and reservoir for increased water supply reliability (limited capability).
9. Repair or replace with larger dam and reservoir with increased conveyance improvements (Calaveras Pumping Plant and Pipeline) for increased water supply reliability.

3. Initial Assessment of the Potential Objectives

Our initial assessment of the potential project objectives is presented in Table 1. We recognize that each of the listed objectives is intended to respond to certain mandates or needs of the Regional Water System plans. At the same time, there are also certain potential issues or barriers that would have to be addressed in order to achieve these objectives. Given the mandates and needs, and the potential issues and barriers, we have attempted to prioritize the objectives into first, second, third and fourth tiers. The tiers are largely based on the time and resources likely required in order to implement a project that would meet the objective(s). The lists of mandates and barriers are not intended to be complete, and the rankings are preliminary. Both require further discussion and confirmation by the SFPUC team. This initial assessment of the objectives may serve as a guide while the team continues to formulate the proposed project.

4. Initial Assessment of Range of Project Alternatives

Tables 2 and 3 present our initial assessment of how well the preliminary range of project alternatives match up with the various potential project objectives. In each case, an alternative equivalent to one of the two original scenarios (same sized or enlarged reservoir) was selected as a "base case" and evaluated in terms of whether or not it meets the list of objectives. Then, the other alternatives were evaluated in terms of their abilities to meet the objectives, *"plus or minus"*, relative to the "base case". Table 2 was developed with Project Alternative 3 (same sized reservoir) as the "base case". Table 3 was developed with Project Alternative 9 (enlarged reservoir) as the "base case".

5. Initial Considerations for Project Objectives Formulation

Additional information will be required in order to screen and rank the alternatives. Tables 2 and 3 illustrate that there would be certain competing project objectives: for example, timeliness and cost-

effectiveness may not be as attainable as the size and complexity of the project increases. Our second memorandum will present more information on the cost and time required to implement the various project alternatives. However, we can make the following preliminary conclusions regarding the formulation of project objectives.

If SFPUC's goal were to implement a project consisting of *Repair or Replacement of the Existing Dam for the Same Storage Capacity*, the project objectives would include:

1. Mitigate public dam safety concerns
2. Restore pre-restriction water supply
3. Complete a project (or phase) to restore pre-restriction water supply as soon as possible
4. Complete the project with minimal environmental impacts
5. Complete the project most cost-effectively
6. Maintain pre-restriction water supply quality
7. Maintain pre-restriction recreation opportunities
8. Improve energy efficiency of reservoir operations
9. Enhance conveyance capacity to SVWTP

The range of project alternatives to be considered and evaluated in the environmental process will include at least Alternatives 1 through 6. The proposed repair or replacement of Calaveras Dam would need to provide a reservoir storage of 96,850 acre-feet, the same as the pre-restriction storage provided by the existing dam. The project could include new outlet works that would satisfy Objective Nos. 7 and 8, assuming new approval from SWRCB is either not required or could be obtained.

If SFPUC's goal were to implement a project consisting of *Replacement of the Existing Dam for Expanded Reservoir Storage Capacity, or Provisions for Future Expansion*, there are three levels to be considered, depending on the size of reservoir storage.

- The Level 1 expanded storage project would include, in addition to the above 9 objectives, the following objective:

  10. Change diversion from Alameda Creek

  Prior estimates by others have indicated that if the Alameda Creek diversion is discontinued, a Calaveras Reservoir increase of at least 24,500 acre-feet is warranted to essentially "break even" in terms of SFPUC system design drought yield.[1] Under such a scenario, the proposed replacement of Calaveras Dam will provide an expanded reservoir storage of about 122,000 acre-feet. Alternatives 4, 7, 8 and 9 could provide such storage.

- The Level 2 expanded storage project would include, in addition to the above 10 objectives, the following objectives:

  11. Augment pre-restriction water supply for increased operational reliability
  12. Augment pre-restriction water supply for drought protection

[1] "Calaveras Reservoir Sizing Considerations", Memorandum by prepared Dan Steiner, April 4, 2002.

The desired level of expanded storage would need to be estimated based on a combination of factors that include the costs (including discrete incremental costs such as saddle dams and road or utility relocations), environmental impacts, and system requirements for supply reliablility. To meet these 12 objectives, it is estimated that the proposed replacement of Calaveras Dam would need to provide an expanded reservoir storage in the range of about 200,000 to 600,000 acre-feet. Alternatives 7 and 8 are intended to provide storage in this range.

- The Level 3 expanded storage project would include, in addition to the above 12 objectives, the following objective:

    13. Develop a regional project that provides water supply for other agencies as well as SFPUC

    To meet all 13 objectives, the proposed replacement of Calaveras Dam would need to provide an expanded reservoir storage of about 670,000 acre-ft. Steiner[1] evaluated an alternative with a reservoir at this size, including increased conveyance capacity from Hetch-Hetchy to the Sunol Valley. This alternative included San Joaquin Pipeline 4 and hydraulic improvements to increase capacity through Coast Range Tunnel, and the necessary interconnection facilities between Sunol Valley and Caleveras Reservoir i.e. Calaveras Pumping Plant and Pipeline. These improvements would enable storage of Hetch Hetchy water in the enlarged Calaveras Reservoir. Steiner's initial assessment suggested that with an expanded Calaveras Reservoir of 670,000 acre-feet, much of SFPUC system deficiencies can be eliminated. Alternative 9 is intended to provide such storage.

It is our understanding that the SFPUC is currently conducting additional studies to further define the system demands and performance requirements regarding reliability, drought resiliency, and peak demands. As part of this study effort, additional information will be developed regarding various projects and programs in order to establish the storage requirements that should be considered for the Calaveras Dam Project.

Exhibit 1 – Scope of Work – Task 2
Attachments: Tables 1 through 3

Exhibit 1
Scope of Work – Task 2

2. ***Remedial Alternatives Evaluation*** *– The objective of this task is to quickly identify and develop conceptual alternatives for the repair and/or replacement of Calaveras Dam. As part of this task, URS will work jointly with a SFPUC team to develop two sets of draft Project Objectives for two alternative reservoir storage scenarios:*

   - *Repair or replacement of the existing dam for the same storage capacity; and*
   - *Replacement of the existing dam for expanded reservoir storage capacity, or provisions for future expansion.*

   Our lead dam engineer and environmental scientist will conduct a site visit. We will review the safety evaluations of the existing dam that are completed and available. Preliminary conceptual alternatives, 3 to 4 each, will be developed for the repair or replacement of the existing dam for same storage capacity, and replacement of the dam for expanded storage capacity. Conceptual alternatives to be considered will be deemed practical, cost-effective and permittable based on past experience. Costs in order of magnitudes will be developed for the conceptual alternatives. The information developed will also serve as a basis for the conceptual engineering.

Our deliverable for this task will include two draft (in progress) technical memoranda: one regarding the project objectives and the other regarding the conceptual alternatives. Two project meetings are assumed for this task.

Table 1 - Calaveras Dam Repair/Replacement P

Potential Objectives
1. Mitigate public dam safety concerns
2. Restore pre-restriction water supply
3. Complete a project (or phase) to restore pre-restriction water supply as soon as possible
4. Complete the project with minimal environmental impacts
5. Complete the project most cost-effectively
6. Maintain pre-restriction water supply quality
7. Maintain pre-restriction recreation opportunities
8. Improve energy efficiency of reservoir operations
9. Enhance conveyance capacity to SVWTP
10. Discontinue diversion from Alameda Creek
11. Augment pre-restriction water supply for increased operational reliability
12. Augment pre-restriction water supply for drought protection
13. Develop a regional project that provides water supply for other agencies as well as SFPUC

[1] Technical issues such as fault locations and borrow area developm
[2] Priority rankings are preliminary and are to be discussed and confi
[3] Other projects in the watershed may be linked to this project result

Table 1 - Calaveras Dam Repair/Replacement Project – Initial Assessment of Potential Project Objectives

Potential Objectives	Mandates / Driving Forces	Potential Institutional Issues / Barriers [1]	Priority[2]
1. Mitigate public dam safety concerns	• Mandate from California Division of Safety of Dams	• Potential linkage to other projects in the watershed [3]	First tier.
2. Restore pre-restriction water supply	• Calaveras provides the essential water supply when the supply from HH is unacceptable • Raker Act Compliance (maximizing use of local supplies)	• Potential linkage to other projects in the watershed	First tier.
3. Complete a project (or phase) to restore pre-restriction water supply as soon as possible	• Calaveras provides the essential water supply when the supply from HH is unacceptable • Encroachment of "incidental" habitat into pre-restriction reservoir area if the reservoir is kept low for an extended period of time.	• Potential linkage to other projects in the watershed	First tier.
4. Complete the project with minimal environmental impacts	• Compliance with CEQA and NEPA and resources permitting agencies requirements	• Potential linkage to other projects in the watershed	First tier.
5. Complete the project most cost-effectively	• Compliance with CIP budgets or justified otherwise	• Potential linkage to other projects in the watershed	First tier.
6. Maintain pre-restriction water supply quality	• Compliance with SFPUC commitment to highest water quality	• Potential linkage to other projects in the watershed	First tier.
7. Maintain pre-restriction recreation opportunities	• Compliance with watershed management plan	• Potential linkage to other projects in the watershed	First tier.
8. Improve energy efficiency of reservoir operations	• Improve efficiency of power consumption for operations	• Linkage to other projects in the watershed	Second tier.
9. Enhance conveyance capacity to SVWTP	• Improve system operational flexibility • Opportunities for stream restoration	• Linkage to other projects in the watershed • Changes in release or diversion may require new approval from SWRCB.	Second tier.
10. Discontinue diversion from Alameda Creek	• Opportunities for stream restoration	• Linkage to other projects in the watershed • Changes in release or diversion may require new approval from SWRCB.	Second tier.
11. Augment pre-restriction water supply for increased operational reliability	• Opportunities to improve water supply reliability • Opportunities for stream restoration	• Linkage to other projects in the watershed • New approval from SWRCB may be required • Time and effort required to complete studies and evaluations in order to establish and support Calaveras as the preferred project	Third tier.
12. Augment pre-restriction water supply for drought protection	• Opportunities to improve water supply reliability • Opportunities for stream restoration	• Linkage to other projects in the watershed • New approval from SWRCB may be required • Time and effort required to complete studies and evaluations in order to establish and support Calaveras as the preferred project	Third tier.
13. Develop a regional project that provides water supply for other agencies as well as SFPUC	• Opportunities to improve water supply reliability • Opportunities for stream restoration • Opportunities to provide high quality Sierra water supplies for local blending • Potential support from CALFED.	• Linkage to other projects in the watershed • New approval from SWRCB may be required • Time and effort required to complete studies and evaluations in order to establish and support Calaveras as the preferred project • Time and effort required by potential project participants to complete studies and evaluations of Calaveras against other regional projects in order to establish and support Calaveras as the preferred project	Fourth tier.

[1] Technical issues such as fault locations and borrow area development, etc. are to be identified separately.
[2] Priority rankings are preliminary and are to be discussed and confirmed by Project Team
[3] Other projects in the watershed may be linked to this project resulting in impediments and delays.

Table 2 - Calaveras Dam Repair/Replacement Pr

Legend

✔ = Meets objective
✕ = Does not meet objective
✚ = Relative to the base case, closer to meeting objective
- = Relative to the base case, farther from meeting objective
? = Currently unknown

Preliminary Range of Project Alternatives
1. Remove the unsafe dam and secure other sources of water supply.
2. Repair or replace with smaller dam and reservoir and secure other sources of water supply.
3. Repair or replace with same size dam and maintain diversion from Alameda Creek.
4. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek.
5. Repair or replace with smaller dam and reservoir and secure other sources of water supply while providing base for future enlargement.
6. Repair or replace with same size dam and reservoir and maintain diversion from Alameda Creek while providing base for future enlargement.
7. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek while providing base for future enlargement.
8. Repair or replace with larger dam and reservoir for increased water supply reliability (limited capability).
9. Repair or replace with larger dam and reservoir with increased conveyance improvements (Calaveras Pumping Plant and Pipeline) for increased water supply reliability.

Table 2 - Calaveras Dam Repair/Replacement Project – Initial Assessment of Range of Project Alternatives with Alternative 3 as the Base Case

Legend

✔ = Meets objective
✖ = Does not meet objective
✚ = Relative to the base case, closer to meeting objective
- = Relative to the base case, farther from meeting objective
? = Currently unknown

Preliminary Range of Project Alternatives	Potential Project Objectives												
	1. Mitigate public dam safety concerns	2. Restore pre-restriction water supply	3. Complete a project (or phase) to restore pre-restriction water supply as soon as possible	4. Complete the project with minimal environmental impacts	5. Complete the project most cost-effectively	6. Maintain pre-restriction water supply quality	7. Maintain pre-restriction recreation opportunities	8. Improve energy efficiency of reservoir operations	9. Enhance conveyance capacity to SVWTP	10. Discontinue diversion from Alameda Creek	11. Augment pre-restriction water supply for increased operational reliability	12. Augment pre-restriction water supply for drought protection	13. Develop a regional project that provides water supply for other agencies as well as SFPUC
1. Remove the unsafe dam and secure other sources of water supply.	✔	-	-	?	?	?	-	-	-	-	-	-	-
2. Repair or replace with smaller dam and reservoir and secure other sources of water supply.	✔	-	-	✔	-	✔	✔	✔	✔	-	-	-	-
3. Repair or replace with same size dam and maintain diversion from Alameda Creek.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✖	✖	✖	✖
4. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek.	✔	✔	✔	✔	✔	✔	✔	✔	✔	✚	✖	✖	✖
5. Repair or replace with smaller dam and reservoir and secure other sources of water supply while providing base for future enlargement.	✔	-	✔	✔	-	✔	✔	✔	✔	-	-	-	-
6. Repair or replace with same size dam and reservoir and maintain diversion from Alameda Creek while providing base for future enlargement.	✔	✔	-	-	-	✔	✔	✔	✔	✖	✚	✚	✚
7. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek while providing base for future enlargement.	✔	✔	-	-	-	✔	✔	✔	✔	✚	✚	✚	✚
8. Repair or replace with larger dam and reservoir for increased water supply reliability (limited capability).	✔	✔	-	-	?	✔	✔	✔	✔	✚	✚	✚	✖
9. Repair or replace with larger dam and reservoir with increased conveyance improvements (Calaveras Pumping Plant and Pipeline) for increased water supply reliability.	✔	✔	-	-	?	✔	✔	✔	✔	✚	✚	✚	✚

Table 3 - Calaveras Dam Repair/Replacement P

<u>Legend</u> ✔ = Meets objective ✕ = Does not meet objective ✚ = Relative to the base case, closer to meeting objective - = Relative to the base case, farther from meeting objectiv ? = Currently unknown
Preliminary Range of Project Alternatives
1. Remove the unsafe dam and secure other sources of water supply.
2. Repair or replace with smaller dam and reservoir and secure other sources of water supply.
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8. Repair or replace with larger dam and reservoir for increased water supply reliability (limited capability).
9. Repair or replace with larger dam and reservoir with increased conveyance improvements (Calaveras Pumping Plant and Pipeline) for increased water supply reliability.

Table 3 - Calaveras Dam Repair/Replacement Project – Initial Assessment of Range of Project Alternatives with Alternative 9 as the Base Case

Legend

✔ = Meets objective
✕ = Does not meet objective
✚ = Relative to the base case, closer to meeting objective
- = Relative to the base case, farther from meeting objective
? = Currently unknown

Preliminary Range of Project Alternatives	Potential Project Objectives												
	1. Mitigate public dam safety concerns	2. Restore pre-restriction water supply	3. Complete a project (or phase) to restore pre-restriction water supply as soon as possible	4. Complete the project with minimal environmental impacts	5. Complete the project most cost-effectively	6. Maintain pre-restriction water supply quality	7. Maintain pre-restriction recreation opportunities	8. Improve energy efficiency of reservoir operations	9. Enhance conveyance capacity to SVWTP	10. Discontinue diversion from Alameda Creek	11. Augment pre-restriction water supply for increased operational reliability	12. Augment pre-restriction water supply for drought protection	13. Develop a regional project that provides water supply for other agencies as well as SFPUC
1. Remove the unsafe dam and secure other sources of water supply.	✔	-	?	?	?	?	-	-	-	-	-	-	-
2. Repair or replace with smaller dam and reservoir and secure other sources of water supply.	✔	-	?	✚	?	✔	✔	✔	✔	-	-	-	-
3. Repair or replace with same size dam and maintain diversion from Alameda Creek.	✔	✔	✚	✚	✚	✔	✔	✔	✔	-	-	-	-
4. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek.	✔	✔	✚	✚	✚	✔	✔	✔	✔	✔	-	-	-
5. Repair or replace with smaller dam and reservoir and secure other sources of water supply while providing base for future enlargement.	✔	-	?	✚	?	✔	✔	✔	✔	-	-	-	-
6. Repair or replace with same size dam and reservoir and maintain diversion from Alameda Creek while providing base for future enlargement.	✔	✔	✚	✚	?	✔	✔	✔	✔	-	-	-	-
7. Repair or replace with larger dam and reservoir to eliminate diversion from Alameda Creek while providing base for future enlargement.	✔	✔	✚	✚	?	✔	✔	✔	✔	✔	-	-	-
8. Repair or replace with larger dam and reservoir for increased water supply reliability (limited capability).	✔	✔	✚	✚	✚	✔	✔	✔	✔	✔	✔	✔	-
9. Repair or replace with larger dam and reservoir with increased conveyance improvements (Calaveras Pumping Plant and Pipeline) for increased water supply reliability.	✔	✔	✕	?	?	✔	✔	✔	✔	✔	✔	✔	✔

SECTION 3

URS

te: December 13, 2002

To: Patty Mallett, SFPUC

m: Mike Forrest, Ted Feldsher, Noel Wong

ct: *Calaveras Dam Evaluations – Contingency Action Plan*
Task 2.2 – Technical Evaluation of Conceptual Dam Repair and Replacement Alternatives

1.0 Summary

This memorandum presents the technical evaluation of conceptual alternatives for repair and replacement of Calaveras Dam. The project objectives for the repair or replacement of Calaveras Dam were discussed in a memorandum dated August 9, 2002.

The repair alternatives include soil improvement (strengthening), external buttressing, and removal/replacement of liquefiable soils. A replacement dam could be constructed downstream of the existing dam.

The dam replacement alternatives are technically preferable to the repair alternatives.

For the repair alternatives, the reservoir would need to be drained and the dam could only be raised minimally. Damage to a repaired structure should be expected following large earthquakes requiring emptying the reservoir and further repairs. A new dam downstream of the existing dam would not require reservoir drainage except, perhaps, for a limited period when the intake is being constructed. A new dam could be built to the present dam crest elevation and raised in the future.

Based on our studies, we recommend that the following alternatives be considered as the "basis for further work" for conceptual engineering studies:

- Dam Repair Alternatives:
    - Buttressing
    - Buttressing with stone column reinforcement
- Dam Replacement and Enlargement Alternatives:
    - Earthfill dam
    - Earth core rockfill dam
    - Concrete–faced rockfill dam
    - Roller compacted concrete dam.

2.0 Introduction

In accordance with the scope of work outlined in our March 27, 2002 proposal (Exhibit 1), URS developed conceptual alternatives for repair or replacement of Calaveras Dam. The alternatives

include projects that would restore the existing reservoir storage, and projects that would provide increased storage. Technical aspects of the various project alternatives were discussed and evaluated by a team of lead URS dam engineers at an August 2, 2002, workshop at our Oakland office. A site reconnaissance was carried out by the team on August 23, 2002 (see Attachment A). The purpose of this memorandum is to summarize the results of the workshop, and to present our preliminary evaluation of the alternatives.

As discussed further below, this memorandum addresses the identified alternatives in terms of technical feasibility, practicality, potential permitting or related issues, and estimated relative cost. Based on the initial screening, we eliminated a number of options that we do not believe merit further study. For the resulting shortlist of alternatives meriting further study, we have developed order-of-magnitude cost estimates for comparison purposes.

The following paragraphs summarize the main categories of project alternatives that were considered. Technical aspects of potential dam repair, replacement, and enlargement projects are also discussed. Technical considerations and evaluations of specific conceptual project alternatives are presented in the attached Tables 1 through 4.

3.0 Preliminary Range of Alternatives

Two categories of project scenarios were originally contemplated in our proposal: (1) repair or replacement of the existing dam for the same storage capacity and (2) replacement of the existing dam for increased reservoir storage capacity. Subsequently, a third category was added: (3) repair or replacement of the existing dam with addition of provisions for future expansion. As discussed in our Draft Memorandum on Project Objectives (dated August 9, 2002), these three categories cover a total of at least nine different project alternatives. For brevity, that list will not be repeated here. For the purposes of technical evaluation of the various dam repair and construction alternatives, we focused on the three main categories of potential projects noted above:

- Repair or replace dam for same reservoir storage (96,850 acre-feet).
- Replace dam for increased reservoir storage (up to 420,000 acre-feet; as explained in Section 5.1).
- Replace dam for same storage but with provision for future enlargement (up to 420,000 acre-feet; as explained in Section 5.1).

For each of these project categories, we identified various pros and cons, potential technical issues, construction issues, and construction materials. The results of our evaluation are presented in the attached tables and discussed below.

The potential maximum reservoir inundation area and fault locations are shown on Figures 1A and 1B, respectively.

4.0 Dam Repair Alternatives

Repair of the existing dam in place was the first category of options considered. Three main approaches to such a repair include:

- external buttressing to stabilize the dam against post-earthquake deformation;
- in-situ soil improvement to remediate liquefiable soils; and
- removal and replacement of some or all of the liquefiable materials in the dam.

These approaches are discussed below and outlined in Table 1.

4.1 Buttressing

Construction of buttress fills would not prevent liquefaction of the materials in the existing dam, but instead would add stability to control post-liquefaction deformations. Based on the studies completed by Olivia Chen Consultants (OCC, 2002), the expected residual strengths of the liquefied materials are low. As such, the required buttresses would be large. Significant foundation excavation would be required to provide for support of the buttresses. Additional drainage and filter layers would be required between the buttress and the existing dam to control seepage and pore pressures as shown on Figure 2B(1).

In order to fully protect the existing dam, both upstream and downstream buttresses would likely be required. Construction of an upstream buttress would require draining the reservoir and construction of a cofferdam and diversion system. The existing low-level and service intakes in the reservoir might require modification. With both upstream and downstream buttresses (Figures 2A and 2B), this alternative offers the opportunity for the dam crest to be raised up to about 20 feet. With this raise, the expanded reservoir storage would be about 122,000 acre-feet. This storage would allow for the Alameda Creek diversion to be discontinued and essentially "break even" in terms of SFPUC system design drought yield ("Calaveras Reservoir Sizing Considerations", memorandum prepared by Dan Steiner, April 4, 2002).

Assuming their capacity was sufficient, the existing spillway and outlet works could most likely be reused. Figure 2A shows that the spillway would not have to be modified to accommodate the buttress fills.

The dam could be stabilized against catastrophic failure by addition of a downstream buttress only. This would not require draining the reservoir for construction. However, such a remediation would not prevent an upstream failure of the existing dam, and the buttress would have to be substantial enough to retain the reservoir if such a failure were to occur. In event of such a failure, the dam would likely not be repairable. Also, the outlet works might require modification so that it could survive an upstream embankment failure.

4.2 In-Situ Soil Improvement

A wide range of soil improvement techniques can be applied to dam projects. In the case of Calaveras Dam, the principal problem with such methods lies in the very high seismic shaking that could occur at the site. In order to control liquefaction-induced displacements, the in-situ remedial construction would need to achieve high degrees of densification (or reinforcement) of the loose hydraulic fill soils in the dam. However, the complex and uncertain internal zonation of the dam (created by the original construction-phase failure and subsequent reconstruction) and the presence of rockfill zones make applicability and control of in-situ methods difficult. The effectiveness of such methods could be uncertain. Nevertheless, potential types of construction methods include vibratory densification, vibratory replacement (i.e., stone columns), jet grouting, deep soil mixing, compaction grouting, and driven piles. Some example projects where these methods have been applied are listed in Table 1. Because of the internal complexity of the dam, a substantial amount of additional geotechnical investigation of the existing dam would be needed for designs using these methods. Even with the additional information, obtaining California Division of Safety of Dams (DSOD) approval to proceed may still prove to be difficult.

In order to carry out in-situ soil improvement to mitigate the dam safety problem, the top 100 feet or so of the dam would likely have to be removed to provide for a construction bench [see Figure 2B(2)]. This would be necessary to gain access and to limit the depth requiring treatment to about 100 feet (applicable for stone columns in particular). Reconstruction of the dam crest to the original elevation would then be required. Because of the required bench excavation and embankment fill replacement, the amount of earthwork for this alternative would likely be comparable to or exceed that for the buttressing alternative discussed in Section 4.1. Assuming their capacity was sufficient, the existing spillway and outlet works could most likely be reused.

4.3 Partial Removal and Replacement

Excavation and replacement of the liquefiable material in the dam is a repair strategy that was considered. However, according to the studies completed by OCC, nearly all of the hydraulic fill material originally placed in the dam core is potentially liquefiable to some degree. The material remaining from the original construction failure in the upstream shell is also problematic. By the time all questionable materials were removed, it is likely that little of the dam would remain. Even much of the outer shell zones might need to be removed, because much of the upstream shell is underlain by material left over from the original failure, and unknown depths of alluvium remain beneath the downstream shell. Construction of filter and drain zones would be required to control seepage and pore pressures. For these reasons, it appears that partial removal and replacement may not be a feasible alternative for further consideration.

For any alternative where dam removal is included, we note that excavation and handling of the hydraulic fill material in the dam will likely be difficult and time consuming. Much of this material has relatively low strengths and high moisture contents, and so it likely cannot be traversed or handled efficiently by typical earthmoving equipment used for dam construction (i.e., scrapers).

5.0 Dam Replacement and Enlargement Alternatives

5.1 Considerations

Key considerations for an enlargement project include: dam axis location, foundation conditions, locations of material sources for construction, dam type considerations, road relocations, utility relocations, and the magnitude of impact to other facilities in the enlarged inundation area. Potential types of dams are listed in Table 2, along with potential dam axis locations.

The site was evaluated for a maximum reservoir water surface at elevation 900 (dam crest elevation 930). The estimated reservoir storage at elevation 900 is about 420,000 acre-feet. This elevation is approximately the maximum that the reservoir water surface could be raised without requiring a saddle dam, which would be located on the active Calaveras fault (see Section 5.2). URS does not recommend constructing a dam across this active fault. Furthermore, constructing a dam across this fault would likely not be permitted by DSOD.

Since the amount of water supply needed from an enlargement project has not yet been defined, projects that restore the existing capacity but have provisions to facilitate future enlargement were considered. The existing outlet works could be modified for smaller raises, but will likely require new construction for enlargements of 50 feet or more. New spillway construction would be required because the dam axis would be shifted downstream necessitating a relocated spillway. These considerations are also summarized in Table 2.

5.2 Site Geologic Conditions

The banks of Calaveras Creek downstream of the dam are underlain by sedimentary rocks, primarily sandstone, which overlies igneous and metamorphic rocks. The metamorphic rocks have been mapped as serpentinite and schist, both as tectonic inclusions in a Franciscan melange, consisting of sheared sandstones and shales. The serpentinite and schist are typically fairly massive and hard, but exhibit significant through-going fractures and occasional sheared, weaker zones. The riprap placed on the dam during the 1974 repairs was obtained from a quarry on the creek's west bank about 2,000 feet downstream from the dam.

Landsliding has been identified on the slopes above Calaveras Creek downstream of the dam, primarily on the eastern hillsides. This is supported by field observations, which disclosed hummocky topography, indicative of sliding. Consideration of dam locations downstream of the existing dam would require detailed investigtion of these slides and their possible impacts on design and construction.

Faulting in the vicinity of the dam has been documented over many years by various investigators. Their interpretation, which has been accepted by the DSOD, is that the nearest active trace of the Calaveras Fault to the dam is through a minor ravine, about 1,000 feet west of the dam (Figure 1B). Another major active strand is located in the topographic saddle through

which Calaveras Road trends, about 2,000 feet west of the dam. Additional details of the fault zone will need to be established at the site for future design studies.

5.3 Construction Materials

Potential sources of embankment core material appear to be present in a relatively flat alluvial plain at the upstream end of the reservoir. Utilizing these materials would require construction of haul roads along the perimeter of the existing reservoir level to the damsite. Potential sources of earth and rock for an embankment dam may be found in the borrow sites used for the original construction or elsewhere around the reservoir area. Random fill material would also be available from excavations to remove portions of the existing dam during construction of the replacement dam. Field investigations will be needed to explore, characterize, and quantify potential borrow sources and potential new dam axis locations.

Known sources of sand and gravel are present on SFPUC property about 5 miles downstream. These materials, which are usually the most expensive in a dam, could be used for filter and drain zones, or for aggregate.

5.4 Dam Type Alternatives

Dam alternatives that were considered for replacement and enlargement are briefly discussed in the paragraphs that follow. The replacement dam (crest elevation 779, USGS datum) would be about 220 feet high and the enlarged dam (crest elevation 930, USGS datum) would be about 370 to 390 feet high.

Figures showing the conceptual plan and typical section of each alternative were prepared. The dam types that were considered are (1) earthfill, (2) earth-core rockfill, (3) concrete-faced rockfill, and (4) roller compacted concrete. The dam sections presented below illustrate concepts for a replacement dam for increased reservoir storage up to 420,000 acre-feet and a replacement dam for the same storage (96,850 acre-feet) but with provision for future enlargement (up to 420,000 acre-feet).

The conceptual dam sections were based on typical earthfill, rockfill and concrete dam designs, with due consideration to the high level of seismic shaking expected at the site. The dam axes were selected to avoid complete removal of the existing dam, and thereby avoid having to drain the reservoir or having to construct a cofferdam upstream of the existing dam. The earth-core rockfill dam, concrete faced rockfill dam, and roller compacted concrete dam were located within 1,000 feet downstream of the existing dam axis. These dams could also be located about 2,000 feet downstream (at the earthfill dam location); the final determination of dam axis location would be based on geologic conditions (e.g., landslides and abutment rock conditions), environmental considerations, and cost.

The dam volumes summarized in Table 3 were estimated based on U.S. Geological Survey quadrangles (1 inch = 2000 feet and 40-foot contour interval). Table 3 also shows reservoir storage capacities and corresponding total reservoir areas for the alternatives.

Earthfill Dam (Figures 3A and 3B): If the rockfill materials would break down sufficiently during excavation, placement and compaction, an earthfill dam would be considered. However, based on our observations of rock outcrops during the site visit and review of the geologic data, this type of dam appears to be unlikely. Core materials for an earthfill dam could be obtained from the potential borrow area at the upstream end of the reservoir. Sand and gravel for filter and drain materials and rock for riprap could be obtained from the commercial sources several miles downstream of the dam. For conceptual estimating, the upstream slope of the dam would be about 3H: 1V and the downstream slope would be about 2.5H:1V. This dam would be located about 1700 feet to 1800 feet downstream of the crest of the existing dam and would require a saddle dam as shown on Figure 3A.

The phased construction section on Figure 3B shows that the core is inclined upstream. The inclined core would reduce the required volume to build the dam to crest elevation 779 and allow for a future raise to elevation 930. The elevation of the horizontal bench in the upstream shell would depend on the amount that the reservoir could be lowered during construction.

Earth-Core Rockfill Dam (Figures 4A and 4B): Rockfill could be quarried from the site area to provide shell materials. Core materials could be obtained from the potential borrow area at the upstream end of the reservoir. Sand and gravel for filter and drain materials and rock for riprap could be obtained from the commercial sources several miles downstream of the dam. For conceptual construction cost estimating, the upstream slope of the dam would be about 2.25H:1V and the downstream slope would be about 2H:1V.

Like the earthfill dam alternative discussed above, the phased construction section on Figure 4B shows that the core is inclined upstream. The inclined core would reduce the required volume to build the dam to crest elevation 779 and allow for a future raise to elevation 930. The elevation of the horizontal bench in the upstream shell would depend on the amount that the reservoir could be lowered during construction.

Concrete-faced Rockfill Dam (Figures 5A and 5B): A concrete-faced rockfill dam was considered to be a viable candidate dam type. For conceptual estimating, the upstream and downstream slopes could be 1.5H:IV. The plinth (the slab that connects the foundation with the upstream concrete face) would be founded on bedrock and also serve as the grout cap. Rockfill would be obtained from quarries on site and the bedding layer material under the concrete slab might be obtained from crushing sandstone onsite or by importing sand and gravel from the commercial sources downstream of the dam.

Roller Compacted Concrete (RCC) Dam (Figures 6A and 6B): An RCC dam was considered at this site. RCC is concrete that is placed using earthmoving equipment and compacted by heavy rollers. RCC technology offers cost and schedule savings over conventional concrete. An RCC

dam would have a vertical upstream face (above a lower sloping portion) and the downstream face would be 0.8H:1V. The dam would have conventional concrete upstream and downstream faces. A multilevel intake would be located on the upstream face of the dam and the outlet conduit would be included within the dam. The spillway would be located in a portion of the dam crest. Aggregate for the RCC could be obtained from the commercial sand and gravel sources downstream of the dam.

6.0 Evaluation of Alternatives

6.1 Basis for Evaluation

Based on the considerations and evaluations presented in this memorandum, many of the potential alternative repair projects can be set aside from further consideration. Because the required storage capacity has not yet been defined, several alternatives remain for consideration, as indicated in Tables 1 and 2.

To provide a basis for further evaluation and decision making by the SFPUC, we have developed order of magnitude comparative construction cost estimates (in 2002 dollars) for short-listed alternatives as shown in Table 4. The alternatives selected for comparative cost estimating are those judged by URS to have the greatest likelihood of being constructed, considering the range of as yet undefined technical, environmental, financial, and institutional issues that have to be evaluated and resolved. The comparative costs are based on historical cost data for URS' projects over the past six years. For the enlarged reservoir alternatives (dam crest elevation 930), costs are included for relocation of about 3 miles of the Calaveras Road. The costs in Table 4 do not include costs for pump stations, transmission facilities, or transfer facilities that are needed for reservoir enlargements.

Table 5 presents a summary of estimated costs for the alternatives that includes (1) environmental documentation and review, (2) conceptual engineering, (3) final design/bid and contract documents, (4) construction management, (5) construction costs from Table 4, and (6) total estimated costs. Allowances for the environmental and engineering costs are based on historical data for similarly complex projects. Costs for construction management are based on construction durations indicated in Table 4. These costs are also based on "third party" construction management; i.e., the construction manger is a separate firm from the design engineer (see memorandum on Task 3 - Project Delivery Alternatives Evaluation). Costs for the design engineer involvement during construction are included in the construction management cost. Allowances for SFPUC's activities that include planning, project management, land acquisition, and for other items are not included in the cost estimates.

Comparative construction durations for the various alternatives were also estimated. Except for the concrete-faced rockfill dam alternative, the construction durations were based on an 8-month construction season per year (mid-March to mid-November), working two 10-hour shifts per day, 6 days per week. Based on this work shift schedule, an embankment placement rate of 22,000 cubic yards (cy) per day (about 4,500,000 cy per year) was assumed. For the concrete-faced

rockfill dam alternative, construction could occur year-round. Using an 8-month construction season, RCC was assumed to be placed at an average rate of 4,000 cy per day. The embankment and RCC placement rates can vary significantly, depending on schedule constraints and productivity assumptions. One construction season was also assumed for site preparation and foundation grouting prior to embankment or RCC placement. The estimated construction durations for the various alternatives are shown in Table 4.

This table also summarizes the ability to raise the alternative dams in the future, estimated required site areas outside of the existing dam, and the main technical issues. The comparative technical feasibility ranking of the alternatives is also indicated in this table.

6.2 Dam Repair Alternatives

The short-listed dam repair alternatives are:

- In-situ Soil Improvement: The only soil improvement alternative that merits further consideration is stone columns. We do have reservations that stone columns would pass the next step in evaluation. The is because (1) stone columns at Calaveras Dam would have to be installed in variable materials making it very difficult to achieve densification on a large scale; (2) the very high seismic loading demand on the dam; and (3) at about 11,000 stone columns, this would be the largest stone column job ever undertaken. (Mormon Island at 6,000 stone columns is the largest to date.) If stone columns are to be considered further, buttressing as described below would also be required.

- Buttressing: Large upstream and downstream earth or rockfill buttresses could be used to stabilize the dam against liquefaction. For this alternative, the reservoir would need to be drained and the dam could only be raised minimally, about 20 feet. Damage to the structure should be expected following large earthquakes, and repair and emptying the reservoir would be required.

6.3 Dam Replacement and Enlargement Alternatives

The dam replacement alternatives discussed in this memorandum are technically feasible. The location of the dam axis for the alternatives will depend on several factors including geologic conditions, environmental considerations, and cost. As indicated below, some alternatives are more amenable to future raising than others.

- The foundation appears to be suitable for an earthfill dam or earth core rockfill dam. These dam types would require confirming the suitability of the core materials at the upstream end of the reservoir.

- The foundation appears to be suitable for a concrete–faced rockfill dam and rockfill materials are available for construction. The concrete-faced rockfill dam alternative appears to offer some advantages: (1) it has a narrower cross section compared to an

earthfill dam or earth-core rockfill dam and thus more flexibility in locating the axis than for the earthfill dam or earth core rockfill dam alternatives; (2) the grouting would not be on the critical path and would expedite embankment construction and shorten the construction schedule; (3) because the entire dam is constructed of rockfill and other granular materials, it can be constructed year-round, thus shortening construction schedule; and (4) the dam is readily amenable to future raises. Other than the RCC dam, the concrete-faced rockfill dam would have the lowest required site area as shown in Table 4.

- The RCC dam offers the advantage of incorporating the spillway and outlet works within the body of the dam, which could result in lower costs, and this dam type is amenable to future raises. RCC aggregate would have to be imported if the durability of the sandstone was found to be unsuitable. Potential shear zones in the foundation could cause stability issues for the RCC dam alternative, especially considering the high earthquake shaking potential at the site.

7.0 Conclusions and Recommendations

Table 4 shows that the dam replacement and enlargement alternatives rank higher than the repair alternatives. For the repair alternatives, the reservoir would need to be drained and the dam could only be raised minimally, about 20 feet (for a storage of about 122,000 acre-feet). Damage to a repaired structure should be expected following large earthquakes requiring emptying the reservoir and further repairs. Although the repair alternatives have several disadvantages, they should be considered further during a conceptual design phase because they have the lowest replacement capital cost. Further studies would be required to assess their suitability considering SFPUC's long-term objectives.

A new dam downstream of the existing dam would not require reservoir drainage except perhaps, for a limited period when the intake is being constructed. A new dam could be raised in the future. Of the dam alternatives, the concrete faced-rockfill dam and RCC dam appear to offer the greatest flexibility for future raises. If future investigations show that the foundation would be acceptable for an RCC dam, the results of the comparative cost estimates in this memorandum indicate that this dam type would have the lowest cost. However, for planning and preliminary budgeting purposes, the concrete-faced rockfill dam alternative should be considered.

Based on our studies, we conclude the following alternatives have merit and recommend that they be considered as the "basis for further work" for conceptual engineering studies:

- Dam Repair Alternatives:
    - Buttressing
    - Buttressing with stone column reinforcement
- Dam Replacement and Enlargement Alternatives:
    - Earthfill dam
    - Earth core rockfill dam

- Concrete-faced rockfill dam
- Roller compacted concrete dam.

Future studies that would be needed to select the preferred alternative would include the following general topics:

- Geotechnical and geologic investigations of the dam foundation, borrow areas, and faulting in the site vicinity;
- Preliminary engineering analyses on stability, hydrology and hydraulics;
- Concept design and cost estimating of the dam and repair/replacement alternatives;
- Concept design of water conveyance facilities for the enlarged reservoir alternatives; and
- Support of environmental documents.

Exhibit 1
Scope of Work – Task 2

2. *Remedial Alternatives Evaluation – The objective of this task is to quickly identify and develop conceptual alternatives for the repair and/or replacement of Calaveras Dam. As part of this task, URS will work jointly with a SFPUC team to develop two sets of draft Project Objectives for two alternative reservoir storage scenarios:*

   - *Repair or replacement of the existing dam for the same storage capacity; and*
   - *Replacement of the existing dam for expanded reservoir storage capacity, or provisions for future expansion.*

   Our lead dam engineer and environmental scientist will conduct a site visit. We will review the safety evaluations of the existing dam that are completed and available. Preliminary conceptual alternatives, 3 to 4 each, will be developed for the repair or replacement of the existing dam for same storage capacity, and replacement of the dam for expanded storage capacity. Conceptual alternatives to be considered will be deemed practical, cost-effective and permittable based on past experience. Costs in order of magnitudes will be developed for the conceptual alternatives. The information developed will also serve as a basis for the conceptual engineering.

   Our deliverable for this task will include two draft (in progress) technical memoranda: one regarding the project objectives and the other regarding the conceptual alternatives. Two project meetings are assumed for this task.

Table 1. Dam Repair Alternatives

Dam Repair Alternatives	Remarks	Consider Further?	Example Projects
1. In-Situ Soil Improvement	All in-situ methods require access to treat inner zones of dam, therefore removal and flattening of at least upper 50 to 100 feet of dam likely required. In-situ methods would present greatest hurdles in terms of gaining DSOD approval.		
A. Stone Columns or Vibratory Densification	Depth limitations of about 100 feet. Questionable whether sufficient densification achievable to prevent liquefaction, due to variable soil conditions, high fines contents, and high seismic loads. Additional buttressing likely required.	Yes	Lopez Dam, California
B. Jet Grouting	Technically doubtful; high costs	No	Wickiup Dam, Oregon
C. Deep Soil Mixing	Technically doubtful; high costs	No	Jackson Lake Dam, Wyoming
D. Compaction Grouting	Technically doubtful; high costs	No	
E. Driven Piles	Applicability doubtful due to large thickness of liquefiable materials.	No	Sardis Dam, Miss.
2. Buttressing	Buttress fills necessary to stabilize the existing dam to resist post-earthquake deformation would be large.		
A. Upstream and Downstream	Requires draining reservoir to access upstream side of dam	Yes	Butt Valley Dam, California
B. Downstream Only	Would not prevent upstream failure, therefore substantial downstream buttress size required. Damage due to design earthquake likely not repairable.	No	Bradbury Dam, California
C. Upstream Only	Requires draining reservoir to access upstream side of dam. Technically impractical. Does not prevent downstream failure.	No	San Pablo Dam, California
3. Partial Removal and Reconstruction			
A. Remove Inner Core and Upper Shell	Portions of upstream and downstream shells remain; incorporated into new dam. Likely to be technically unacceptable as liquefable materials remain in dam.	No	
B Remove Downstream Shell and Core	Upstream shell acts as cofferdam and incorporated into new dam. Technically questionable whether upstream shell is okay.	No	
C. Breach Dam and Construct New Dam Downstream	This is a dam replacement project. New or extended outlet works required. See Table 2.	Yes	Upper San Leandro Dam, California

Table 2. Dam Replacement and Enlargement Alternatives

Dam Replacement Alternatives	Remarks	Consider Further?	Example Projects
1. Dam Type			
A. Earthfill	Borrow source for core materials needed; potential source is at upstream end of reservoir. Would require confirming the suitability of the core materials. Existing hydraulic fill would need to be dried out to use for new construction. Would require sloping core to raise the dam in the future.	Yes	Los Vaqueros Dam and others in the Bay Area; Judy Reservoir Expansion, WA.
B. Earth Core Rockfill	Borrow source for core materials needed; potential source is at upstream end of reservoir. Would require confirming the suitability of the core materials. Would require sloping core to raise the dam in the future.	Yes	Diamond Valley Lake, Riverside County, CA
C. Concrete-faced Rockfill	Has a narrower cross section compared to the earthfill dam or earth core rockfill dam and thus has more flexibility in locating the axis. Has shorter construction duration because grouting would not be on the critical path and because the dam is constructed of rockfill and other granular materials so it can be constructed year-round. The dam is amenable to future raises.	Yes	New Spicer Meadows, CA
D. Roller Compacted Concrete	Typically requires relatively good quality foundation rock. Potential shear zones in the foundation could cause stability issues for the roller compacted concrete dam alternative, especially considering the high earthquake shaking potential at the site. Flatter than typical slopes may allow use here. The roller compacted concrete dam offers the advantage of incorporating the spillway and outlet works within the body of the dam and is amenable to future raises.	Yes	Pajarito Canyon, NM; Sheep Creek Dam, AK (staged construction); Stage Coach, CO
2. Dam Location			
A. Existing Axis (with complete removal of existing dam)	Requires upstream cofferdam and draining reservoir for construction. May allow reuse of existing spillway and outlet works, depending on capacity requirements and height of dam.	Yes	
B. Axis Upstream of existing dam	Available dam sites less efficient, and would have earthquake fault crossing issues. This would be an unacceptable alternative.	No	
C. Axis 500 to 1000 feet downstream of existing dam	Leave portion of upstream shell as cofferdam but do not incorporate in new dam. Potential abutment landslides. New or extended outlet works required. New spillway required.	Yes	
D. Axis 1000 to 2500 feet downstream of existing dam	Potential abutment landslides. Possible reuse of existing tunnel for outlet works or diversion.	Yes	

Table 3. Summary of Alternatives

Alternative	Crest El.*	Max. W.S. El.*	Reservoir Capacity (acre-feet)	Reservoir Area (acres)	Dam Axis Location D/S of Existing Dam Crest (ft)	Estimated Total Volume (million cy)
1. Upstream and Downstream Buttresses	779	756	96,850	1500	At existing dam axis	4.1
	800	776	122,000	1700	At existing dam axis	4.3
2. Upstream and Downstream Buttresses with Stone Columns	779	756	96,850	1500	At existing dam axis	4.5
	800	776	122,000	1700	At existing dam axis	4.7
3. Earthfill Dam	930	900	420,000	2900	1800	12.5
	779	756	96,850	1570	1670	5.3
4. Earth Core Rockfill Dam	930	900	420,000	2850	950	10.7
	779	756	96,850	1520	850	4.0
5. Concrete-faced Rockfill Dam	930	900	420,000	2850	800 – 900	7.7
	779	756	96,850	1520	620 - 720	2.1
6. Roller Compacted Concrete Dam	930	900	420,000	2850	800	2.1
	779	756	96,850	1520	800	0.6

* USGS Datum

URS

Alternative
1. Construct upstream and downstrear buttress fills wide enough to contro earthquake deformation.
2. Remove upper 100 feet of dam, con stone columns to densify and reinfo lower 100 feet of dam, and rebuild ' addition of buttress fills upstream ai downstream.
3. Earthfill Dam
4. Earth Core Rockfill Dam
5. Concrete-faced Rockfill Dam
6. Roller Compacted Concrete Dam

Notes:
a. Costs are in 2002 dollars.
b. Crest el. 930 based on the maximum re
c. Costs and durations are for dam alterna
d. For crest el. 800: Alternative 1 cost =
e. Construction costs are for dams that ca
f. Costs do not include pumping stations

Table 4. Potential Alternatives For Further Study

Alternative	Ability to Raise in Future	Main Issues	Est. Required Site Area (outside of existing dam) (acres)		Estimated Comparative Construction Costs[a]		Estimated Construction Durations (years)		Comparative Feasibility Rank
			Crest El. 779	Crest El. 930[b]	Crest El. 779	Crest El. 930[b,c]	Crest El. 779	Crest El. 930[b,c]	
1. Construct upstream and downstream buttress fills wide enough to control earthquake deformation.	Probably minimal, to about crest elev. 800.	• Need to drain reservoir. • Damage is expected to dam following large earthquakes; reservoir emptying and dam repair would be required.	8	N/A	$50 million[d]	N/A	2	N/A	Low
2. Remove upper 100 feet of dam, construct stone columns to densify and reinforce lower 100 feet of dam, and rebuild with addition of buttress fills upstream and downstream.	Probably minimal, to about crest elev. 800.	• Need to drain reservoir. • Stone column treatment is technically questionable. • Damage is expected to dam following large earthquakes; reservoir emptying and dam repair would be required.	6	N/A	$80 million[d]	N/A	3	N/A	Low
3. Earthfill Dam	Can raise in future to crest elev. 930, but initial configuration would be larger than for dam that would not be raised.	• Need to confirm suitability of core borrow materials.	34	80	$150 million[e]	$355 million[f]	2½	4	Medium
4. Earth Core Rockfill Dam	Can raise in future to crest elev. 930, but initial configuration would be larger than for dam that would not be raised.	• Need to confirm suitability of core borrow materials.	23	53	$145 million[e]	$360 million[f]	2	3½	Medium-High
5. Concrete-faced Rockfill Dam	Dam is amenable to a future raise to crest elev. 930.	• Site quarries would need to furnish free-draining rockfill within certain zones of the dam.	16	40	$80 million[e]	$260 million[f]	2	3	High
6. Roller Compacted Concrete Dam	Dam is amenable to a future raise to crest elev. 930.	• Foundation acceptability would have to be verified; shear zones could pose seismic stability issues.	5	11	$50 million[e]	$130 million[f]	2	3½	Medium

Notes:
a. Costs are in 2002 dollars.
b. Crest el. 930 based on the maximum reservoir water surface without requiring a saddle dam on the Calaveras Fault. See memorandum Section 5.1.
c. Costs and durations are for dam alternatives constructed in one phase to crest el. 930.
d. For crest el. 800: Alternative 1 cost = $52 million; Alternative 2 cost = $82 million.
e. Construction costs are for dams that can be raised to crest el. 930 in the future [for storage up to el. 900 (up to 420,000 acre-feet)].
f. Costs do not include pumping stations and transmission and transfer facilities.

Table 5. Summary of Estimated Costs of Alternatives (in $ million)

Alternative	Reservoir Capacity (ac-ft)	Environmental Documentation & Review	Conceptual Engineering	Final Design/ Bid & Contract Documents	Construction Management	Construction	Total Estimated Cost
1. Upstream & Downstream Buttresses	96,850	2	3	5	12	50	72
	122,000	2	3	5	12	52	74
2. Upstream & Downstream Buttresses with Stone Columns	96,850	2	3	5	18	80	108
	122,000	2	3	5	18	82	110
3. Earthfill Dam	420,000	3	4	5	24	355	391
	96,850	2	3	5	15	150	175
4. Earth Core Rockfill Dam	420,000	3	4	5	21	360	393
	96,850	2	3	5	12	145	167
5. Concrete-faced Rockfill Dam	420,000	3	4	5	18	260	290
	96,850	2	3	5	12	80	102
6. Roller Compacted Concrete Dam	420,000	3	4	5	21	130	163
	96,850	2	3	5	12	50	72

Attachment A

Calaveras Dam Evaluation - Contingency Action Plan
Task 2.2 - Technical Evaluation of Conceptual Dam Repair and Replacement Alternatives
Field Reconnaissance

1.0 Purpose and Scope

A site reconnaissance visit to the Calaveras Dam and vicinity was conducted on August 23, 2002, to confirm dam types for a modified or raised dam. The purpose of the site visit was to observe site topography and geologic conditions to aid in evaluation of dam types. This trip report supports Task 2.2 - Technical Evaluation of Conceptual Dam repair and Replacement Alternatives.

2.0 Site Visit Activities

Ted Feldsher, Ray Rice and Mike Forrest (URS) met John Snow, Associate Civil Engineer with the Utilities Engineering Bureau, Construction Engineering Division, of the San Francisco PUC, who accompanied us to the site. We were on site from about 9 AM to 1:30 PM.

We traveled to the following areas:

- Quarry site about 1500 feet downstream of the left (west) abutment of the dam where we observed rock conditions.

- The top of the hill downstream of the left abutment where we observed conditions on the right abutment of the dam.

- The lower part of the right abutment and channel bottom where we observed the tunnel outlet portal and pipeline.

- Upstream end of the reservoir where we observed a potential core borrow area.

3.0 Geological Observations

The most recent geologic mapping of the damsite vicinity (Geomatrix, 2002) draws upon previous mapping by a number of other investigators (Crittenden, 1951; Cotton, 1972; Dibblee, 1973; 1980).

The left abutment of the dam and the west side of Calaveras Creek downstream are underlain by Tertiary sedimentary deposits, primarily the Temblor sandstone, which unconformably overlie igneous and metamorphic rocks of the Franciscan assemblage. These Franciscan materials have been mapped as serpentinite and glaucophane blueschist,

both as tectonic inclusions in a Franciscan melange, consisting of sheared sandstones and shales.

The dam's right abutment and the eastern bank of Calaveras Creek downstream also consist of Franciscan melange, with major inclusions of serpentinite/glaucophane blueschist, which stand out as resistant outcrops on the hillside. The serpentinite/ glaucophane blueschists are typically fairly massive and hard, but exhibit significant through-going fractures and occasional sheared, weaker zones. The riprap placed on the dam during the 1974 repairs was obtained from a quarry on the creek's west bank about 2,000 feet downstream from the dam. Visual observations indicate that more material could be developed from this source.

Abundant landsliding has been identified on the slopes above Calaveras Creek downstream of the dam (Nilsen, 1975), primarily on the eastern hillsides. This is supported by field observations, which disclosed hummocky topography, indicative of sliding. Consideration of dam locations downstream of the existing dam would require detailed investigation of these slides and their possible impacts on design and construction.

Faulting in the vicinity of the dam has been documented over many years by various investigators, the most recent being Geomatrix (2002). Their interpretation, which has been accepted by the DSOD is that the nearest active trace of the Calaveras Fault to the dam is through a minor ravine, about 1,000 feet west of the dam. Another major active strand is located in the topographic saddle through which Calaveras Road trends, about 2,000 feet west of the dam.

4.0 Borrow Areas and Construction Materials

<u>Materials:</u> The relatively flat alluvial plain at the upstream end of the reservoir was observed for potential core borrow materials. The site area was covered with low grasses and was dusty. The surficial materials contain silty soils with low to non-plastic fines. The dried surficial materials did not exhibit shrinkage cracks.

The soil survey of eastern Santa Clara Area (USDA, SCS, 1974) indicates that the soils in the possible borrow area are identified as Yolo loam which has the following typical profile:

- 0 to 29 inches: Moist; very dark grayish brown loam; massive; hard; friable; non-sticky and non-plastic;

- 29 to 60 inches: Brown silt loam; moist; massive; hard; friable; non-sticky; and non-plastic.

The soil is classified as ML in the Unified Soil Classification System, with 80 to 90% passing the No. 200 sieve, a liquid limit of 35 to 45 and a plasticity index of 5 to 10.

Hazardous materials are reportedly present in this borrow area. If this borrow area is to be used for dam construction, the hazardous materials would need to be delineated and characterized.

Random fill material would also be available from excavations to remove portions of the existing dam during construction of the replacement dam. Durable sand, gravel, and rock materials could be obtained from commercial operations located several miles downstream of the dam along Calaveras Road.

Material Hauling: Transporting the materials from the borrow area at the upstream end of the reservoir would require construction of a haul road. An existing unpaved road on the east side of the reservoir, located along most of the route between the borrow area and the dam, may be partly utilized for the haul road. However, this road would require extensive earthwork to widen and grade the road for heavy truck hauling. A route along the shoreline would also be possible. A temporary crossing (bridge or embankment causeway) would be required across the Arroyo Hondo arm. The total distance of this haul road would be about 5 to 6 miles.

The west side of the reservoir is a potential haul route, but would have to be separate from the existing road. A haul road along the west shoreline would be about 6 to 7 miles long. For a reservoir water surface elevation at about elevation 900 (see Section 5.0), the haul road could link with the northern 2 miles of the existing county road adjacent to the reservoir. This portion of the county road would have to be relocated in a separate prior contract.

5.0 Dam Type Assessment

Maximum Reservoir Water Surface Elevation and Dam Axes: The site was evaluated for a maximum reservoir water surface at elevation 900. This elevation is the maximum that the reservoir water surface could be raised without requiring a saddle dam. A saddle dam would be located on the active Calaveras fault, which would complicate permitting the project with DSOD.

The site topography and geologic conditions downstream of the dam were evaluated for potential dams. Dam axes were considered that could be located as far downstream as the quarry.

Earth-Core Rockfill Dam: Rockfill (sandstone and serpentinite/schist) could be quarried from the site area to provide shell materials. Core materials could be obtained from the borrow area at the upstream end of the reservoir. Sand and gravel for filter and drain materials and rock for riprap could be obtained from the commercial sources several miles downstream of the dam. Due to the long haul distance for core materials, the core

volume would be minimized and the width of the core would be about half the height of the dam at any given elevation.

Earthfill Dam: If the rockfill materials would break down sufficiently during excavation, placement and compaction, an earthfill dam would be considered. However, based on our observations during the site visit and review of the geologic data, this type of dam appears to be unlikely.

Like the earth core rockfill dam, core materials for an earthfill dam could be obtained from the borrow area at the upstream end of the reservoir. Sand and gravel for filter and drain materials and rock for riprap could be obtained from the commercial sources several miles downstream of the dam. Similar to the earth core rockfill dam, the core volume would be minimized and the width of the core would be about half the height of the dam at any given elevation due to the long haul distance for core materials.

Concrete-faced Rockfill Dam: A concrete-faced rockill dam was considered to be a viable candidate dam type. The plinth (the slab that connects the foundation with the upstream concrete face) would be founded on bedrock and also serve as the grout cap. Rockfill would be obtained from quarries on site and the bedding layer material under the concrete slab might be obtained from crushing sandstone onsite or by importing sand and gravel from the commercial sources downstream of the dam.

Roller Compacted Concrete (RCC) Dam: The foundation was evaluated for potential RCC dam construction. The foundation appeared to be composed of sound hard rock. However, due to the likelihood of shear zones in the rock (which were observed in the left abutment, including talc zones) foundation stability would be an issue.

Aggregate for the RCC may be obtained from crushed quarried sandstone, but the durability of this rock would have to be evaluated. Crushing the serpentinite would likely result in flat, elongated particles and might not be a suitable aggregate source. The commercial sand and gravel sources downstream of the dam could provide aggregate materials.

6.0 Conclusions

Based on this site visit, we have the following preliminary conclusions on dam types:

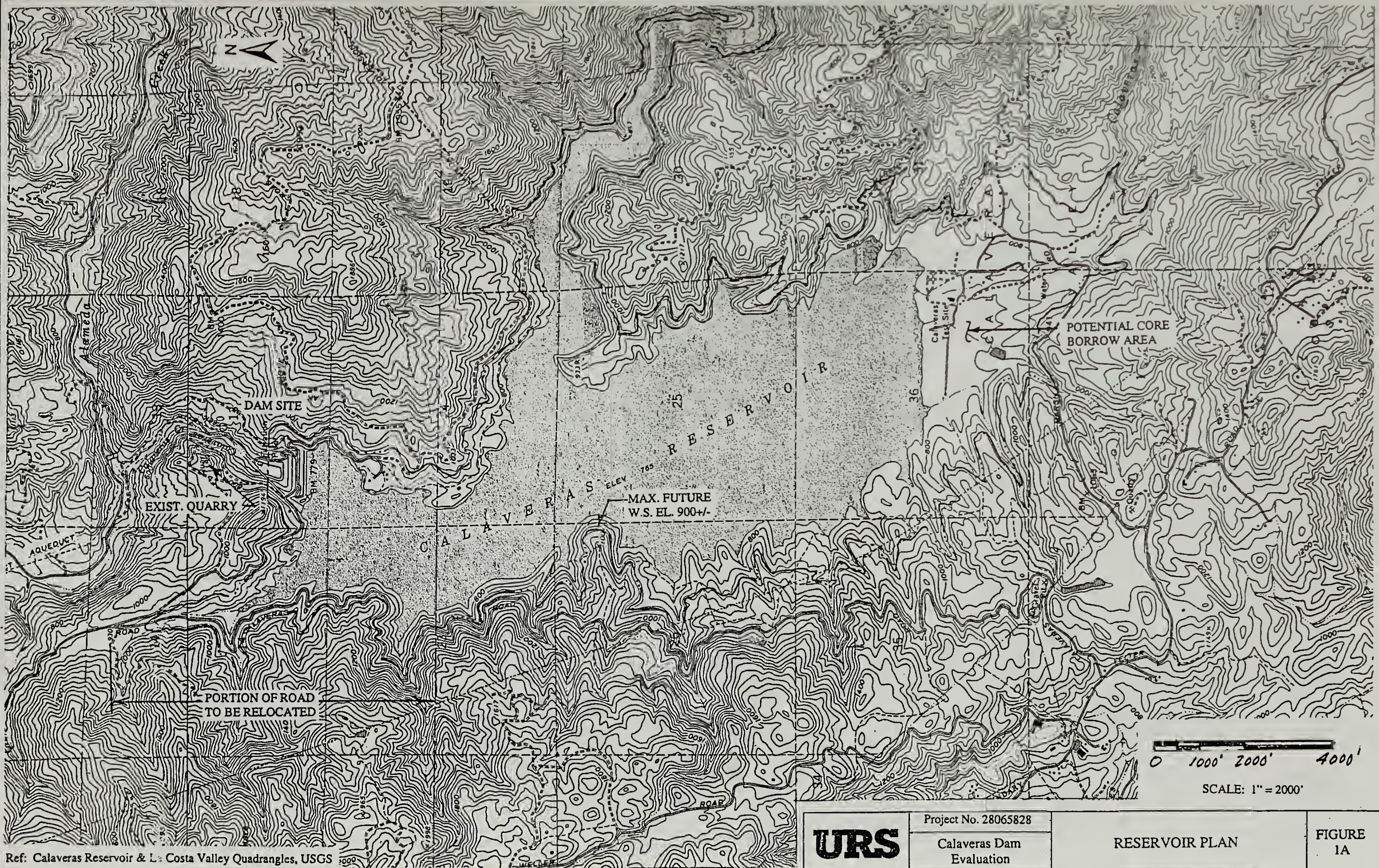
- The foundation appears to be suitable for an earth core rockfill dam or earthfill dam. These dam types would require confirming the suitability of the core materials at the upstream end of the reservoir. Test pits and limited laboratory test data would be needed to characterize subsurface materials and their suitability for core materials.

- The RCC dam would incorporate the spillway and outlet works within the body of the dam and is amenable to future raises. RCC aggregate would have to be imported if the sandstone could not be used. Potential shear zones in the foundation could cause

stability issues for the RCC Dam alternative, especially considering the high earthquake shaking potential at the site.

- The foundation appears to be suitable for a concrete-faced rockfill dam and rockfill materials are available for construction. This dam type is amendable to future raising.

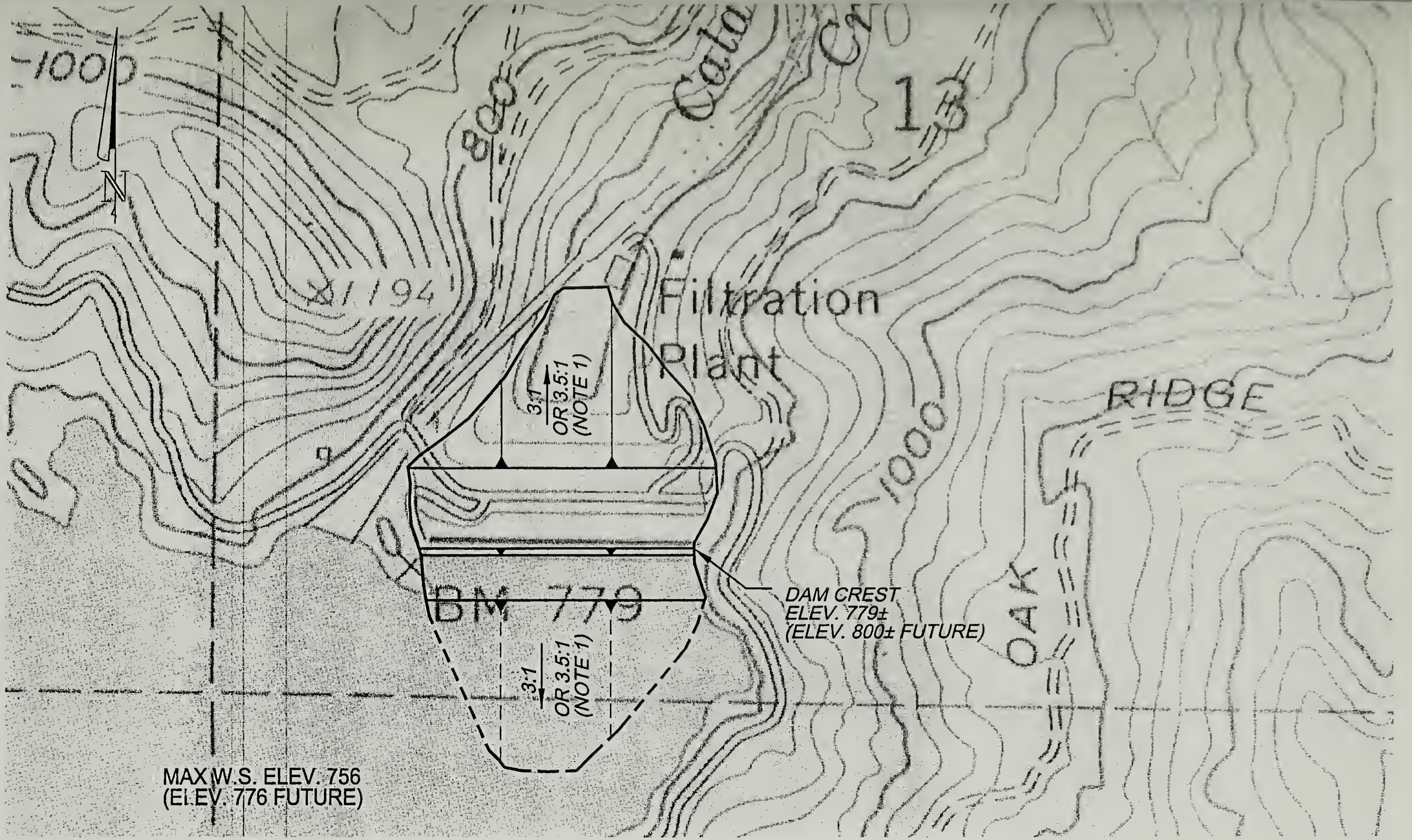
The final selection of dam type would be based on environmental, constructibility, cost, and other project objective considerations.



Ref: Calaveras Reservoir & La Costa Valley Quadrangles, USGS

URS	Project No. 28065828 Calaveras Dam Evaluation	RESERVOIR PLAN	FIGURE 1A

URS	Calaveras Dam Evaluation 28065828	CALAVERAS RESERVOIR AND FAULT LOCATIONS	Figure 1B

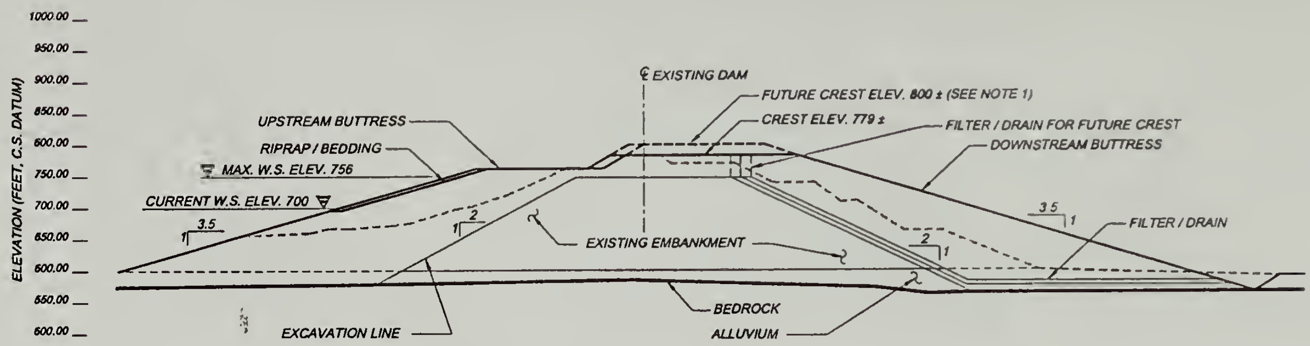


REF: TOPO BASE FROM CALAVERAS
RESERVOIR QUADRANGLE, USGS

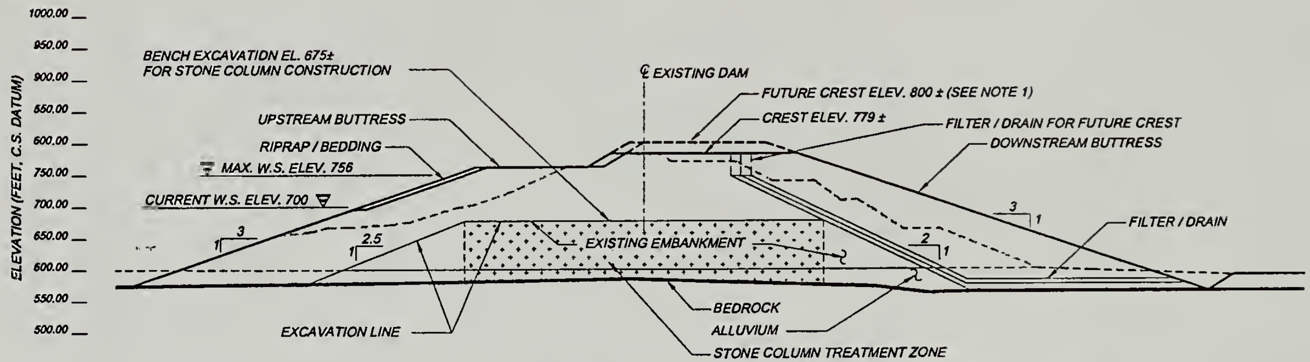
NOTE:
1. SEE FIGURE 2B FOR SLOPES.

0' 250' 500' 1000'
1" = 500'

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	UPSTREAM & DOWNSTREAM BUTTRESS PLAN CONCEPT	FIGURE 2A



(1) UPSTREAM & DOWNSTREAM BUTTRESSES



(2) UPSTREAM & DOWNSTREAM BUTTRESSES WITH STONE COLUMNS

NOTE:

1. MAX. W.S. ELEV.=776 FOR DAM CREST AT ELEV. 800.

200' 0' 100' 200' 400'

1"=200'

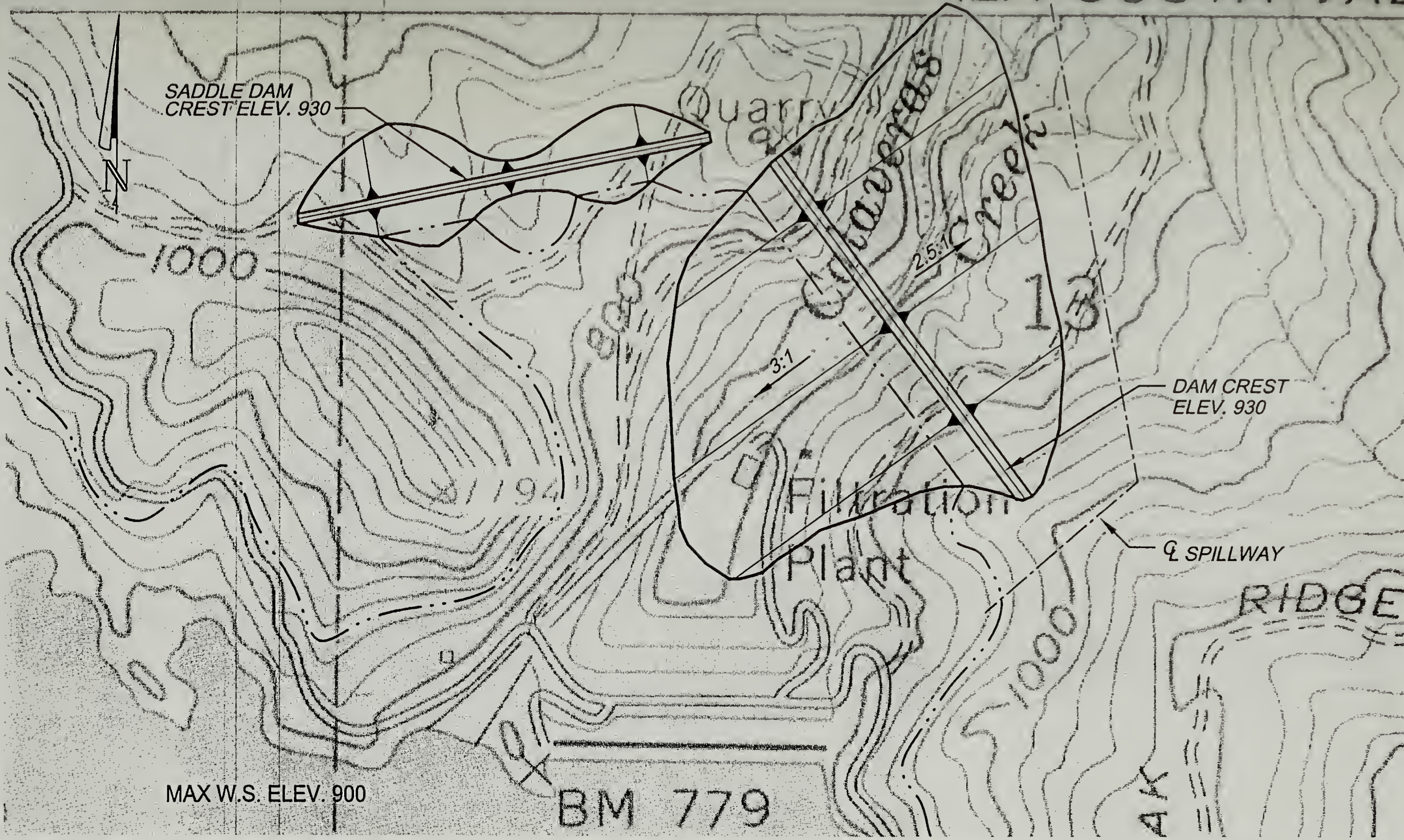
URS

Project No. 28065828

CALAVERAS DAM EVALUATION

UPSTREAM AND DOWNSTREAM BUTTRESSES – SECTIONS CONCEPT

FIGURE 2B

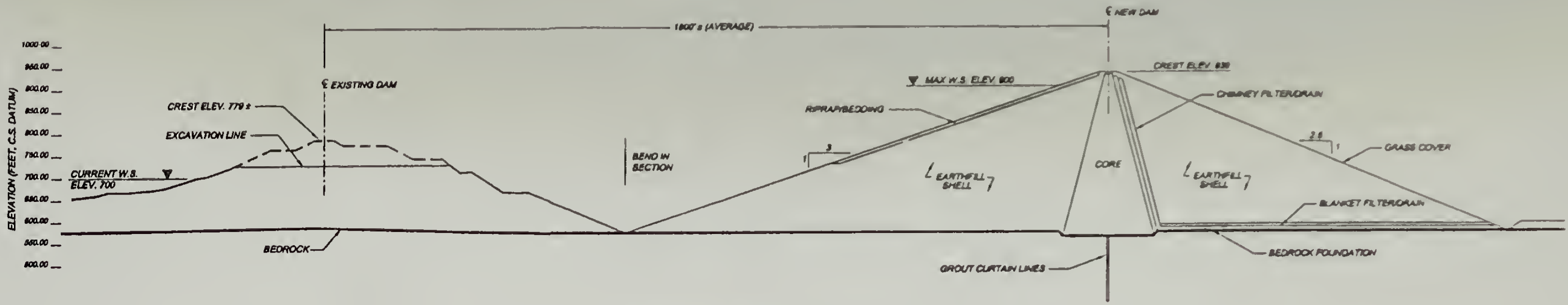


REF: TOPO BASE FROM CALAVERAS
RESERVOIR QUADRANGLE, USGS

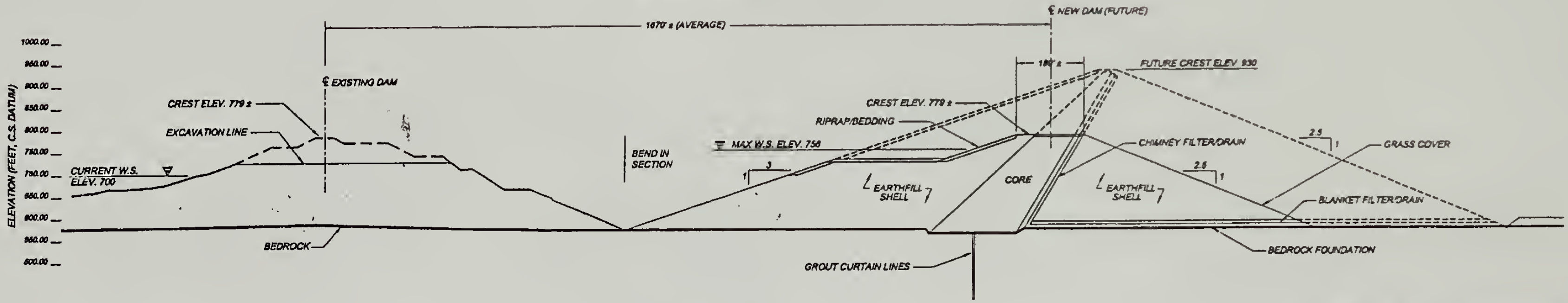
NOTE: EXCAVATION OF EXISTING DAM NOT SHOWN.

0' 250' 500' 1000'
1" = 500'

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	EARTHFILL DAM PLAN CONCEPT	FIGURE 3A



SINGLE PHASE CONSTRUCTION

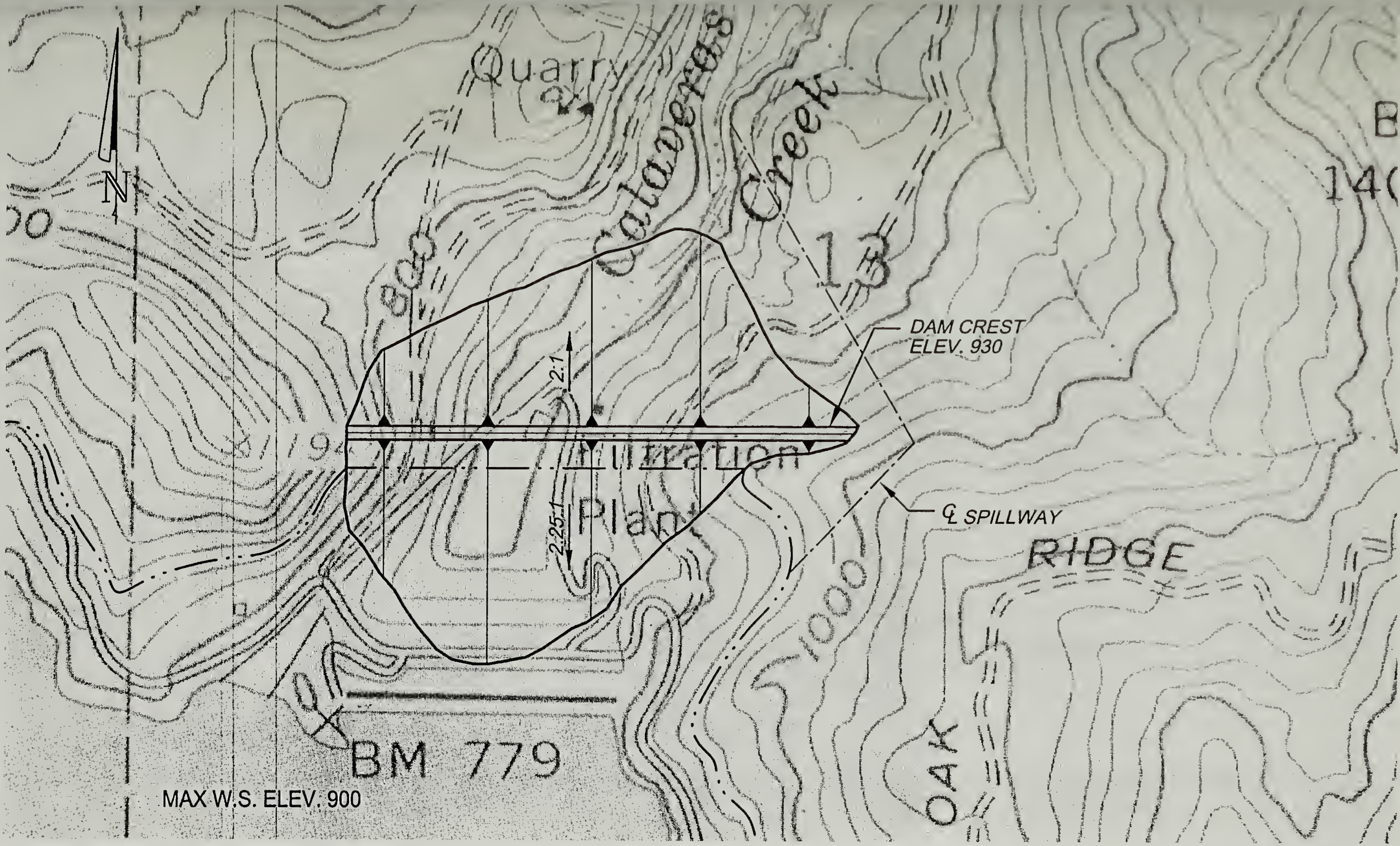


PHASED CONSTRUCTION

200' 0' 100' 200' 400'

1"=200'

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	EARTHFILL DAM SECTIONS CONCEPT	FIGURE 3B

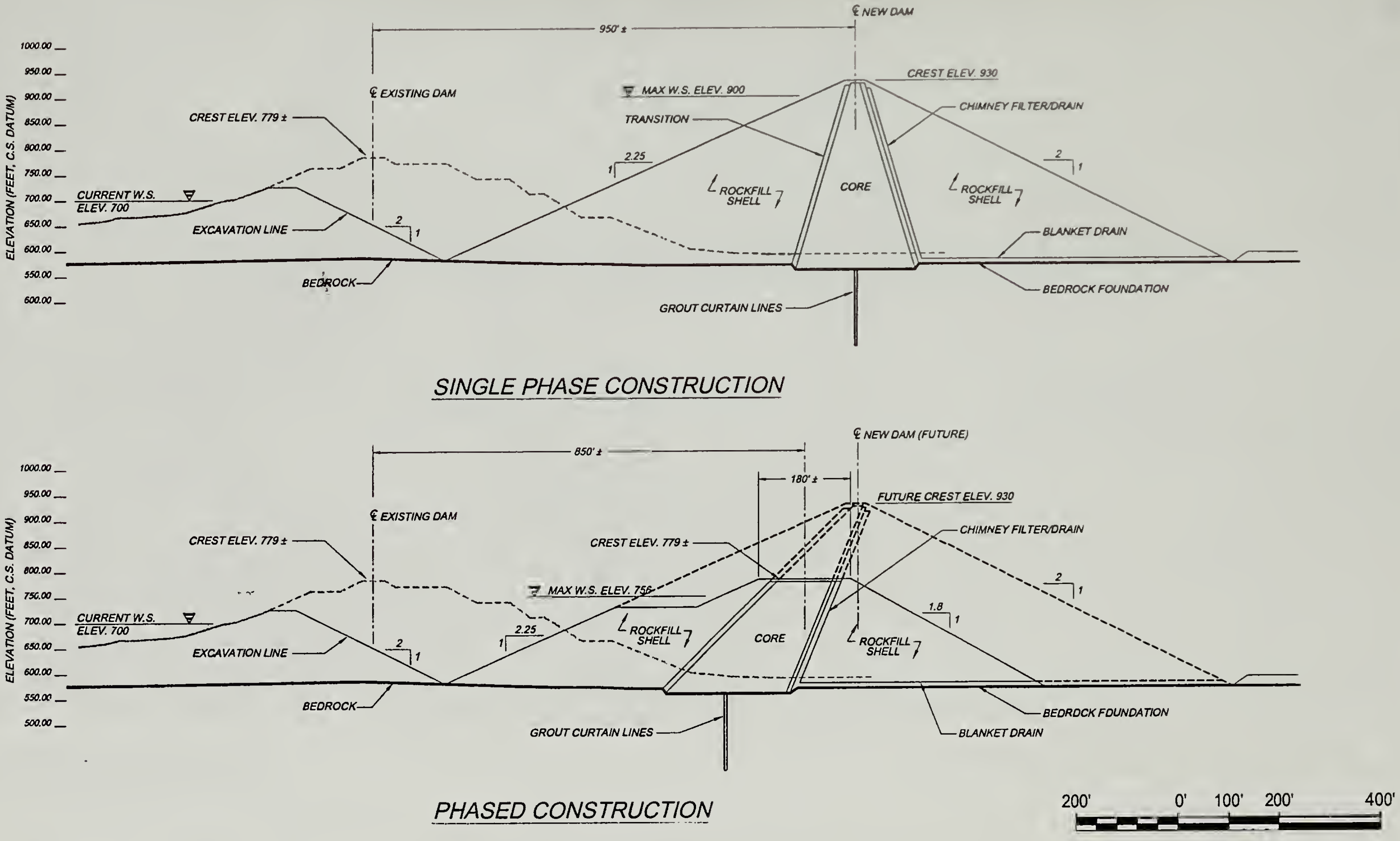


REF: TOPO BASE FROM CALAVERAS
RESERVOIR QUADRANGLE, USGS

NOTE: EXCAVATION OF EXISTING DAM NOT SHOWN.

0' 250' 500' 1000'
1" = 500'

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	EARTH CORE ROCKFILL DAM PLAN CONCEPT	FIGURE 4A



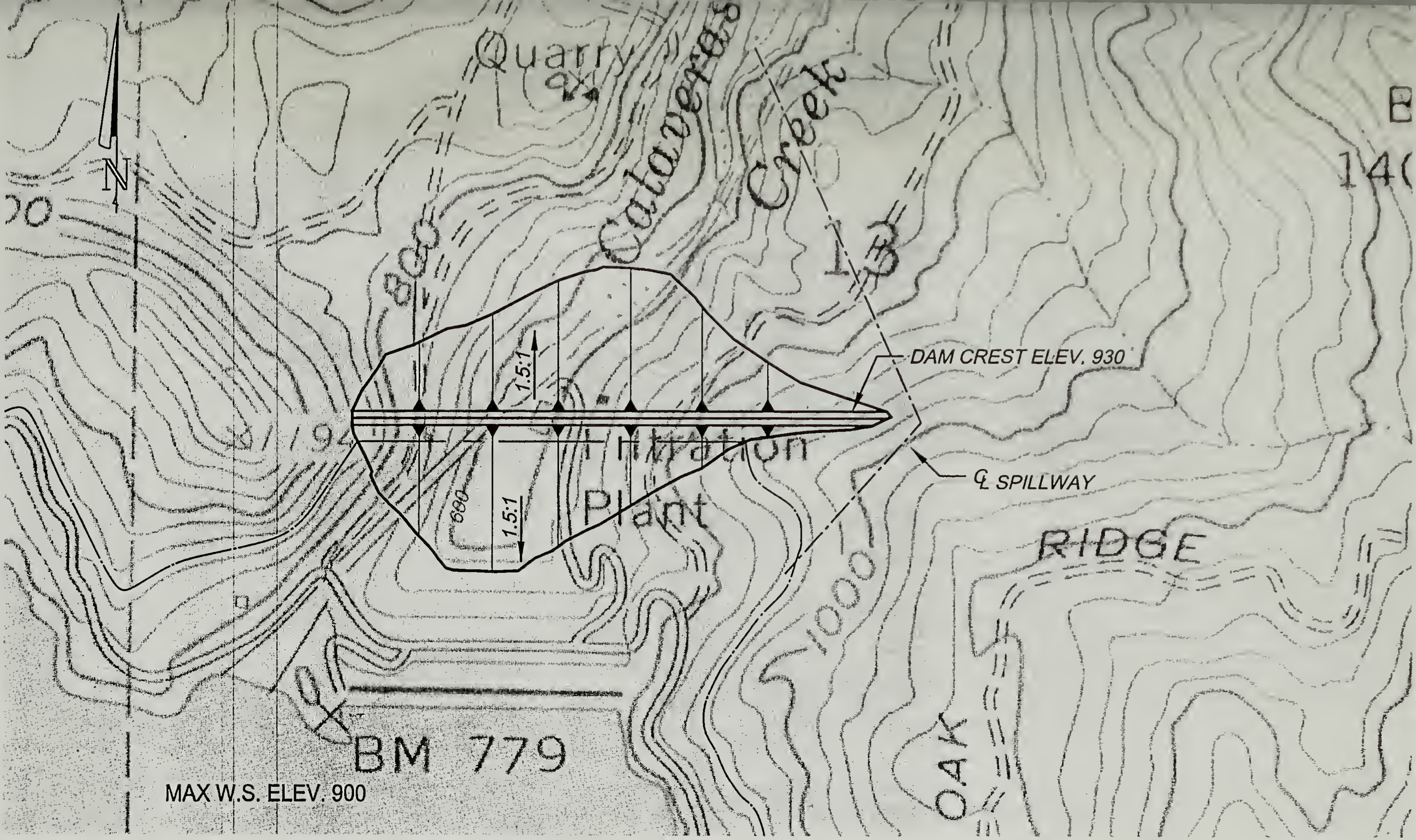
URS

Project No. 28065828

CALAVERAS DAM EVALUATION

EARTH CORE ROCKFILL DAM SECTIONS CONCEPT

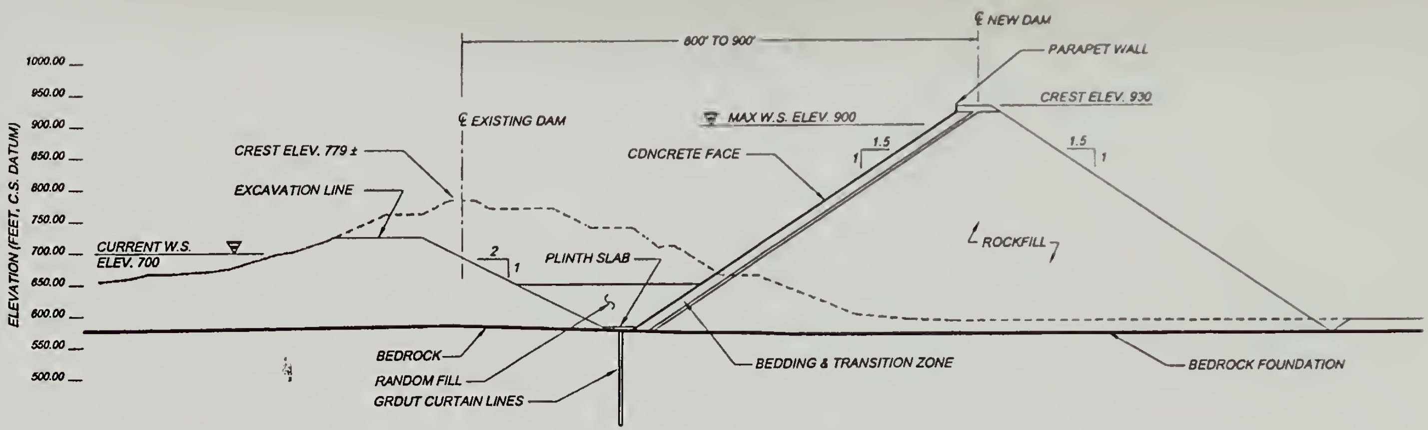
FIGURE 4B



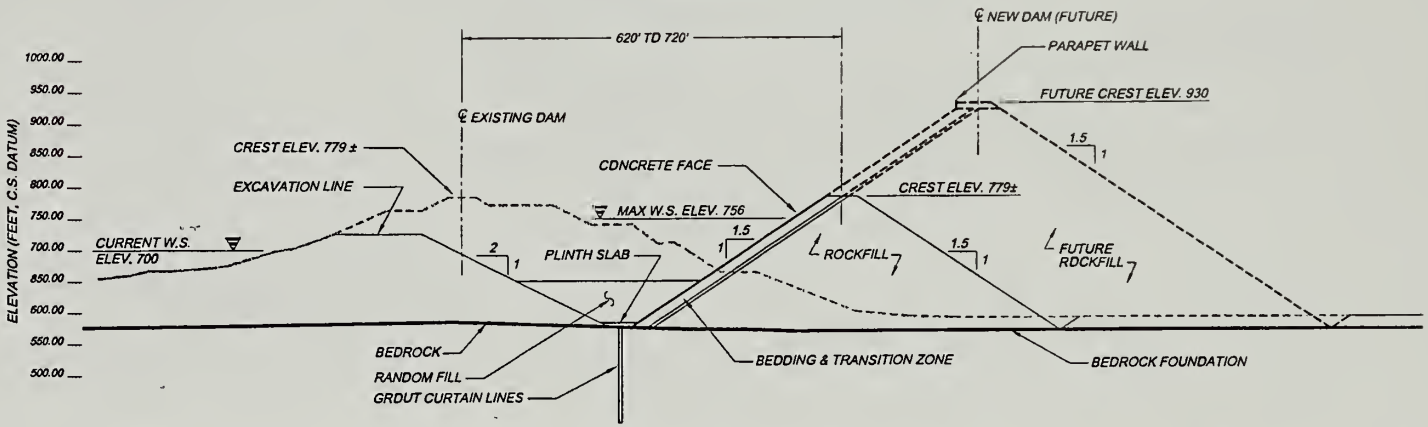
REF: TOPO BASE FROM CALAVERAS
RESERVOIR QUADRANGLE, USGS

NOTE: EXCAVATION OF EXISTING DAM NOT SHOWN.

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	CONCRETE – FACED ROCKFILL DAM PLAN CONCEPT	FIGURE 5A



SINGLE PHASE CONSTRUCTION

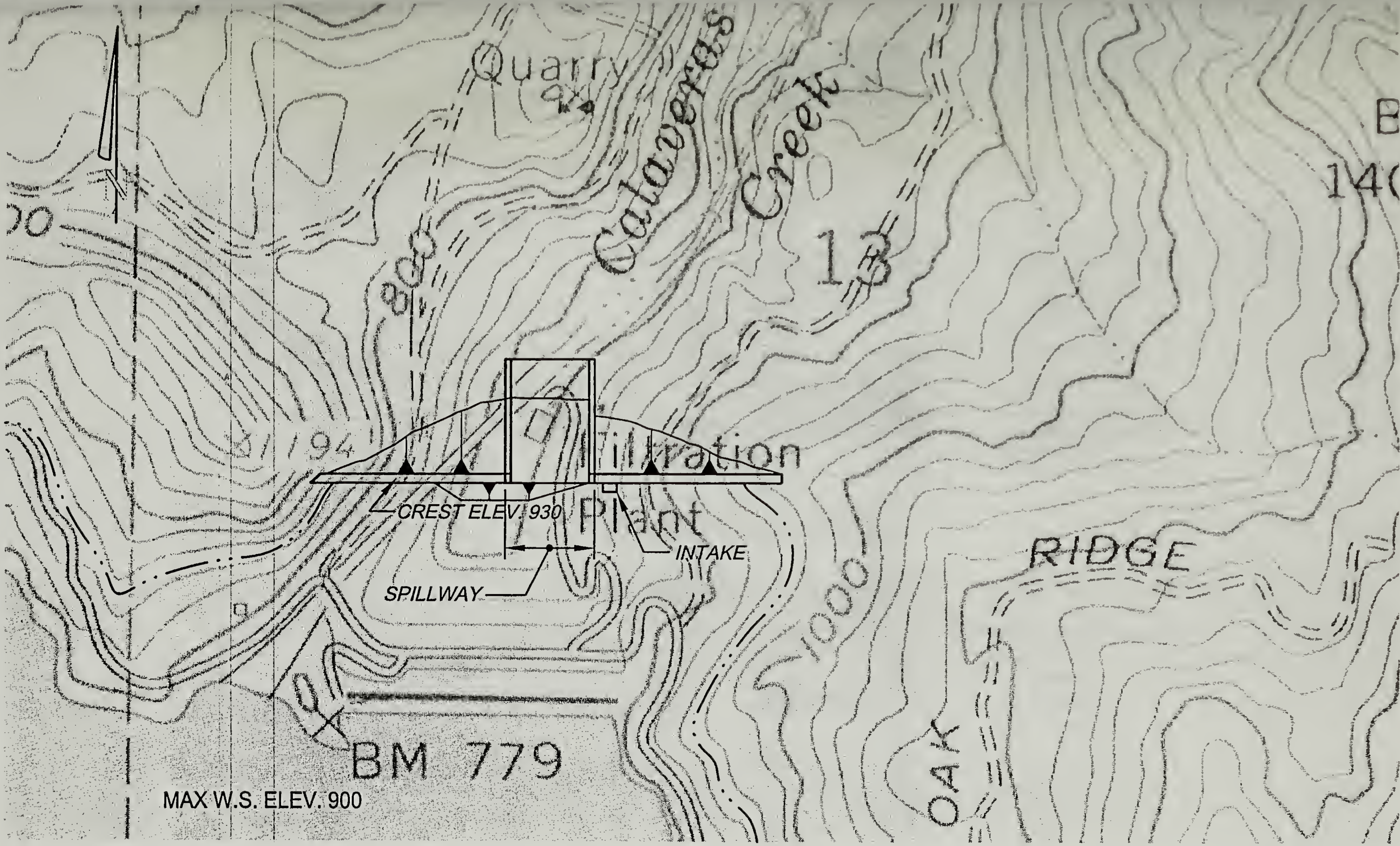


PHASED CONSTRUCTION

200' 0' 100' 200' 400'

1" = 200'

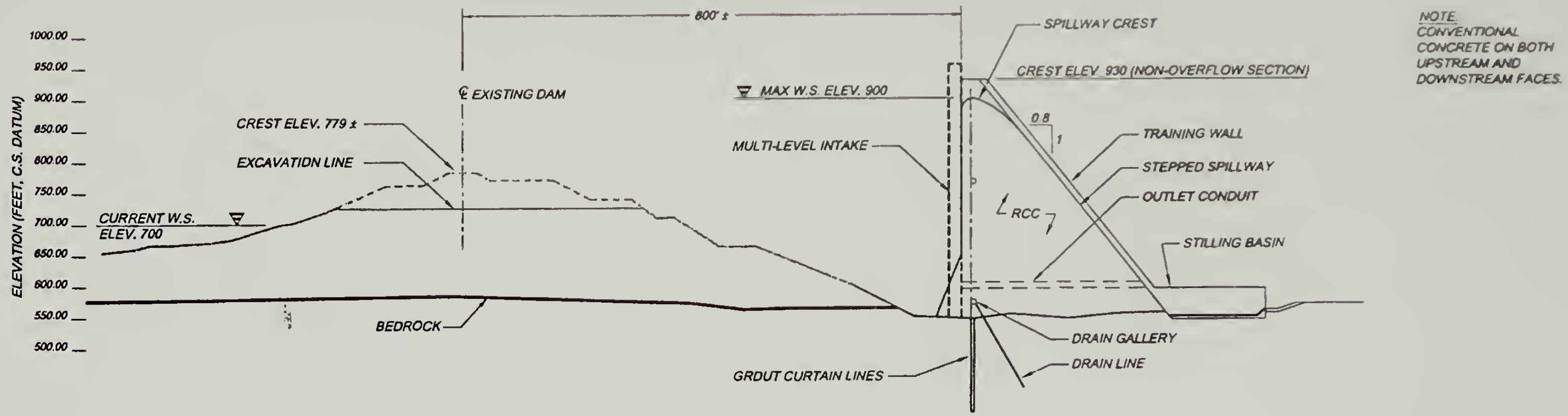
URS	Project No. 28065828 CALAVERAS DAM EVALUATION	CONCRETE–FACED ROCKFILL DAM SECTIONS CONCEPT	FIGURE 5B



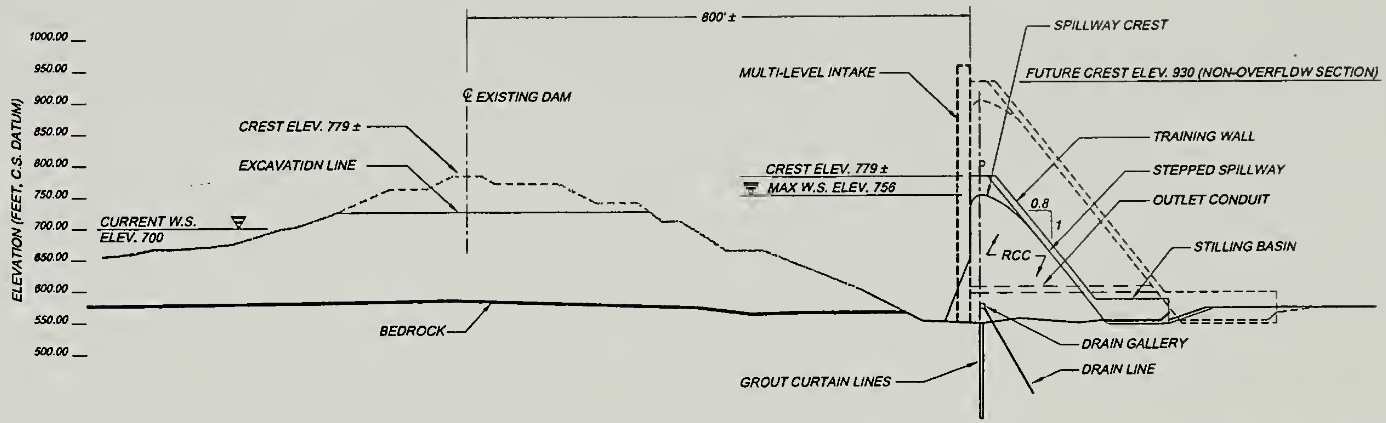
REF: TOPO BASE FROM CALAVERAS
RESERVOIR QUADRANGLE, USGS

NOTE: EXCAVATION OF EXISTING DAM NOT SHOWN.

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	ROLLER – COMPACTED CONCRETE DAM – PLAN CONCEPT	FIGURE 6A



SINGLE PHASE CONSTUCTION



PHASED CONSTRUCTION

200' 0' 100' 200' 400'

1"=200'

URS	Project No. 28065828 CALAVERAS DAM EVALUATION	ROLLER – COMPACTED CONCRETE DAM – SECTIONS CONCEPT	FIGURE 6B

SECTION 4

URS

ate: January 21, 2003

To: Patty Mallett, SFPUC

rom: Mike Forrest, Noel Wong

ject: *Calaveras Dam Evaluations – Contingency Action Plan*
Task 3 – Project Delivery Alternatives Evaluation

1.0 Introduction

In accordance with the scope of work outlined in our March 27, 2002, proposal (Exhibit 1), URS prepared this project delivery alternatives evaluation memorandum for repair or replacement of Calaveras Dam. The purpose of this memorandum is to assist the SFPUC in planning and scheduling the engineering, environmental, and construction work necessary to implement a successful Calaveras Dam project.

This memorandum presents potential scope of work descriptions and associated work schedules for completing the environmental process, permitting, design, and construction phases of the Calaveras Dam work. We have outlined four potential work schedules for projects including replacement or repair of the existing dam and construction of an enlarged dam. Schedules were prepared that represent sequential engineering and environmental review, which is SFPUC's normal approach. Schedules were also prepared that present concurrent engineering and environmental review to show a more aggressive approach that has been used on other reservoir projects and which would shorten the project completion time.

In light of the potential magnitude and complexity of the projects being considered, we believe that consultant and technical expert selection will be critical to the ultimate success of the work. Therefore, this memorandum also offers our opinions on several key factors for SFPUC to consider in the selection process.

As indicated in our separate memorandum on Technical Evaluation of Conceptual Dam Repair and Replacement Alternatives, three main categories of potential projects are under consideration at this time:

- Repair or replace dam for same reservoir storage (96,850 acre-feet).
- Replace dam for increased reservoir storage (up to 420,000 acre-feet*).
- Replace dam for same storage but with provision for future enlargement (up to 420,000 acre-feet*).

*Note: 420,000 acre-feet storage is the current estimate of the maximum feasible storage. The final enlarged dam project configurations and storage quantities have yet to be determined.

These potential projects formed the basis for preparing this memorandum on project delivery alternatives evaluation.

2.0 Critical Success Factors

We believe that at least three main factors are critical to the success of the Calaveras Project: (1) selection of the right design consultant, (2) selection of the right construction management team, and (3) appointment of an expert technical review committee.

2.1 Design Consultant Selection

Due to the technical complexity and magnitude of the potential projects, the SFPUC will likely need to retain a design consultant to carry out the work. Ideally, such a design consultant will be intimately involved with the project throughout all stages from concept to completion. The design engineering consultant must be able to quickly develop and maintain close and effective working relationships with the SFPUC's project team and with other key players within the SFPUC. As part of this process, the design consultant must be able to elicit, understand, and successfully address SFPUC's key project concerns and requirements. The following are key success factors that the engineering consultant will need to be able to demonstrate:

- Understanding of SFPUC's needs and a proven ability to work with SFPUC staff and management.
- Technical expertise and experience (from both the firm and the individual team members) in planning, designing, and constructing dams and associated hydraulic facilities for large reservoir projects at geotechnically challenging sites.
- Proven experience in preparing reliable construction cost estimates and meaningful constructibility evaluations for dam construction projects.
- A long-term working relationship and high level of trust and mutual respect with the California Division of Safety of Dams (DSOD).
- Experience working closely and cooperatively with environmental consultants and permitting agencies.
- Demonstrated ability to understand and cooperate with Habitat Conservation Plan (HCP) work.

2.2 Construction Management Team

The SFPUC, who has significant resources and experience in construction management, should take a leadership role in the construction management of the Calaveras Dam Project. However, for large dam projects, the design engineer should have a significant role during construction. This is because important design development and refinement inevitably occurs during the construction phase of such projects.

One potentially efficient way to approach construction management would be with a combined team composed of key personnel from both the SFPUC and the design consultant. Ideally, such a team would put responsible decision-makers from both parties at the site. This would greatly streamline both the engineering and administration elements of the project. One example

division of responsibility would be to have the SFPUC personnel responsible for contract administration aspects while consultant personnel would take charge of design-related coordination, engineering, and quality control tasks. Such an approach was successfully used at the recently completed Diamond Valley Lake Project.

If SFPUC desires to have a third party construction manager (different from the designer) to administrate the construction contract, we strongly recommend that the construction manager be selected early during the design process. The construction manager should be tasked with reviewing the drawings and specifications and providing timely input, so that they have the opportunity to "buy-in" to the contract documents that they will have to enforce. Without such buy-in, undesirable internal friction between the designer and the construction manager sometimes occurs, to the project's detriment.

A third option where there can be substantial efficiency benefits is to have the designer and the construction manager be from the same firm. With this approach, duplication of effort and inefficiency would be minimized and the SFPUC would benefit from reduced administration costs. The SFPUC would also benefit from having a single firm with professional responsibility for preparing the design and monitoring its implementation.

2.3 Technical Review Committee

Due to the large size and the technically complex nature of the potential project, we recommend that SFPUC retain an independent Technical Review Committee. The committee's role would be to independently review the engineering design work and to advise SFPUC throughout the design and construction phases of the project. Expert technical review committees are standard practice on large or complex dam and reservoir projects, particularly those where seismic hazards are significant. The Los Vaqueros and Diamond Valley Lake projects provide two relatively recent examples. With the right members, these committees can provide valuable expertise during design process and can afford high credibility when presenting the project to the DSOD and other key stakeholders. The committee should be composed of senior specialists and experts in fields such as seismology, geology, earthquake engineering, dam design and construction, hydraulic structures, and mechanical/electrical components.

3.0 Project Phases and Work Scopes

The following sections present a logical breakdown of the engineering work for the Calaveras Dam project into three separate phases. These include conceptual engineering, final design, and construction management. Proposed objectives, goals, and deliverables are presented for each phase of the work.

3.1 Phase 1: Conceptual Engineering Report

The principal objective of Phase 1, Conceptual Engineering Report, is to evaluate the following alternatives:

(1) repair the existing dam
(2) construct a new dam to replace the existing dam, and
(3) construct an enlarged dam.

The Conceptual Engineering Report should recommend a preferred alternative for each of the repair/replacement or enlargement dam alternatives. For the new replacement dam option, the design should be adaptable to expansion so as not to preclude the potential for future enlargement. This phase includes conceptual engineering for the dam, spillway, outlet works, and road relocation. Engineering for the conveyance facilities and for decommissioning of the existing dam, appurtenant works, and the Alameda Creek diversion works would also be needed for the enlarged dam. The studies for this phase are focused on performing the work required to evaluate the alternatives from technical, constructibility, cost, and schedule aspects. Close coordination with SFPUC via meetings and workshops will be essential during this phase. Coordination and review with DSOD will also be important. Recommendations for a preferred alternative will be submitted to SFPUC . The SFPUC should then be able to select the preferred alternative, based on the results of the Phase 1 Conceptual Engineering Report, the meetings/workshops, and Technical Review Committee meetings. A principal goal of the Phase 1 work will be to obtain concurrence from DSOD on the selected conceptual alternative for either replacing/repairing or enlarging Calaveras Dam.

The potential scope of work and deliverables for the Phase 1 tasks are presented in Appendix A.

3.2 Phase 2: Final Design

The principal objective of Phase 2 is full design development for the selected project alternative. The final design will include contract documents, plans, specifications, and related reports. Together these documents will comprise a bidding package with which the SFPUC can advertise and solicit bids for the work. Phase 2 will culminate in review of bids received and assistance to the SFPUC in the selection of a construction contractor.

Phase 2 includes final investigations, final engineering and analyses, submittals of plans and specifications at the 30%, 60%, 90% and final levels, construction cost estimates, and interaction with DSOD. This phase also includes design reviews with the Technical Review Committee, SFPUC, and DSOD. As part of this phase, plans for consideration of multiple construction packages to expedite the construction work will be considered. Provisions in the contract documents for addressing value engineering and risk management will also be considered.

The potential scope of work and deliverables for the Phase 2 tasks are presented in Appendix B.

3.3 Phase 3: Construction Management

The principal objective of Phase 3 is to manage and administer the construction contract so that the completed project is in conformance with established project requirements and quality standards, is finished on time, and is done within the SFPUC's allotted budget.

The main elements of Phase 3 will include field engineering, inspection and testing, contract administration, and design engineering support, both in the field and from the home office. As is typical for large projects involving earthworks and heavy civil construction, substantial involvement of the designer during construction is expected. As discussed above, if SFPUC desires to have a third party construction manager to administer the construction contract, the construction manager should be selected no later than the 60% design submittal, so that the construction manager can have meaningful review input and buy-in to the design process.

The potential scope of work and deliverables for the Phase 3 tasks are presented in Appendix C.

4.0 Project Delivery Systems

With conventional design/bid/build packaging, the engineering and construction are done by separate firms, and construction follows only after the design is completed. With design/build packaging, on the other hand, the engineering and construction are combined in a single entity, and design can be completed concurrently with construction. Based on our prior experience, we believe that design/bid/build is likely the most appropriate approach for the Calaveras Dam project. This is because of the complex technical issues that need to be addressed in the design and approved by DSOD before construction. Because the time constraints for the DSOD approval process would be much greater with a design/build approach, the DSOD does not normally favor that method of contracting.

Another possibility for expediting the work via contract packaging would be by use of multiple contract packages. Multiple contracts have the potential to expedite schedule and reduce costs as described below. We recommend that the possibilities for such packaging be evaluated as part of the final design phase of the work.

- Potentially expedited schedule: Several packages of the work can proceed independently, either concurrently or as early contracts while design is proceeding on other parts of the project.

- Potentially lower costs: For example, construction could be divided into dam construction, water conveyance systems (for enlarged reservoir), and road relocation contract packages. Such division of work could promote more competition due to the wider range of contractors that could bid the various packages.

5.0 Implementation Schedule

To assist the SFPUC with conceptualizing and planning for the work involved in implementing a Calaveras Dam project, we have developed the following four conceptual project schedules:

- Dam Repair/Replacement (same storage) - Version 1: sequential engineering and environmental review (Figure 1)

- Dam Repair/Replacement (same storage) - Version 2: concurrent engineering and environmental review (Figure 2)
- Dam Enlargement - Version 1: sequential engineering and environmental review (Figure 3)
- Dam Enlargement - Version 2: concurrent engineering and environmental review (Figure 4).

Schedule Version 1 (Figures 1 and 3) represents sequential engineering and environmental review and is SFPUC's normal approach. In this approach, conceptual engineering would be performed prior to starting the environmental documentation and review process. Final design would begin after completion of the Final Environmental Impact Report (FEIR). It is noted that we have assumed that a Programmatic Environmental Impact Report would not be required for a repair or replacement project for the same storage capacity. Schedule Version 2 (Figures 2 and 4) represents concurrent engineering and environmental review, which is a more aggressive approach. This approach was successfully used for the Contra Cost Water District's Los Vaqueros Project completed in 1997. In this approach, conceptual engineering would be performed concurrently with the environmental documentation and review process. Final design would begin after completion of conceptual design.

The following table summarizes the estimated project completion [quarter (Q) and year] and the estimated total project duration shown on Figures 1 to 4:

Approx. Project Completion/ Project Duration	Dam Repair/Replacement		Dam Enlargement	
	Sequential Eng/Env	Concurrent Eng/Env	Sequential Eng/Env	Concurrent Eng/Env
Project Completion	Q1, 2011	Q3, 2009	Q2, 2013	Q2, 2011
Project Duration (years)	8	7	10	9

As shown above, concurrent engineering and environmental review could result in a project completion about one year to 1½ years before the process that involves sequential engineering and environmental review. The estimated durations shown above are dependent on the length of the environmental impact studies and the environmental permitting process, both of which can potentially take longer time to complete. For that reason, the actual project durations could be longer than shown in these preliminary schedules. Nonetheless it appears that the concurrent engineering and environmental review approach is worth further consideration if SFPUC wishes to expedite the completion of the project.

The preliminary schedules on Figures 1 to 4 show the main phases of the project, the involvement of the SFPUC, DSOD, permitting agencies, and the engineering and environmental consultants, and the interdependencies of the various phases and the critical paths. All durations indicated were roughly estimated based primarily on our prior experience with similar projects. The schedules show estimated times for DSOD approvals at key design phases, although we note that the DSOD involvement will continue from the start of conceptual design through final

completion of construction. The environmental permitting process periods shown on the schedules would extend through final design.

5.1 Dam Repair/Replacement - Version 1: Sequential Engineering and Environmental Review

Conceptual engineering in this schedule version (Figure 1) would begin in quarter (Q)3, 2003, after a 6-month consultant selection process. The 12-month conceptual engineering phase would conclude prior to the start of the Draft Environmental Impact Report (DEIR) documentation process in Q3, 2004. The FEIR would be completed in Q3, 2006. After the completion of the FEIR, final design would begin (after a design consultant selection process), and would have a duration of about 23 months. SFPUC would begin the selection process for the construction manager in Q2, 2007, so that the construction manager would be available to review the design consultant's 60% submittal. The bid period would begin in Q3, 2008 (bid open 3 months later), with notice to proceed (NTP) for construction in Q1, 2009. We estimate that construction of the replacement dam or repair of the existing dam would take about 2 years, with completion in Q1, 2011. The total project duration for the replacement dam or repaired dam is estimated to be about 8 years.

5.2 Dam Repair/Replacement - Version 2: Concurrent Engineering and Environmental Review

With this schedule, conceptual engineering and preparation of the DEIR are concurrent, and both would begin in Q3, 2003, after a 6-month consultant selection process (see Figure 2). The 12-month conceptual engineering phase would provide information for the DEIR documentation process; the FEIR would be completed in Q3, 2005. After the CER is submitted, the SFPUC would commence with the design consultant selection (Q3, 2004). Final design engineering would begin in Q1, 2005, and would have a duration of about 23 months. SFPUC would begin the selection process for the construction manager in Q4, 2005, so that the construction manager would be available to review the design consultant's 60% submittal. The bid period would begin in Q1, 2007 (bid open 3 months later), with notice to proceed (NTP) for construction in Q3, 2007. We estimate that construction of the replacement dam or repair of the existing dam would take about 2 years, with completion in Q3, 2009. This schedule shows a total estimated project duration for the replacement dam or repaired dam of about 7 years, or about one year to 1½ years less than the duration indicated in Version 1.

5.3 Dam Enlargement - Version 1: Sequential Engineering and Environmental Review

As indicated in Figure 3, the schedule for this alternative shows conceptual engineering, preparation of the Habitat Conservation Plan (HCP), and CIP programmatic environmental documentation beginning in Q3, 2003, after a 6-month consultant selection process. The 18-month conceptual engineering phase would conclude prior to the start of the DEIR documentation process in Q1, 2005; the FEIR would be completed in Q1, 2007. It is noted that 18 months is estimated (rather than 12 months for dam repair/replacement) because of the need

to design a pump station and conveyance facilities for a dam enlargement. After the FEIR is submitted, final design engineering would begin in Q1, 2007 (after a design consultant selection process), and would have a duration of about 26 months. This estimated duration is 3 months longer than that for the replacement dam due to the increased design work for the pump station and conveyance facilities. SFPUC would begin the selection process for the construction manager in Q1, 2008, so that the construction manager would be available to review the design consultant's 60% submittal. The bid period would begin in Q2, 2009 (bid open 3 months later), with NTP for construction in Q4, 2009. Construction of the dam enlargement would be completed in 3 years, with completion in Q2, 2013. The total project duration for the enlarged dam is estimated to be about 10 years.

5.4 Dam Enlargement - Version 2: Concurrent Engineering and Environmental Review

As indicated in Figure 4, the schedule for this alternative shows conceptual engineering, preparation of the Habitat Conservation Plan (HCP), and CIP programmatic environmental documentation beginning in Q3, 2003, after a 6-month consultant selection process. The 18-month conceptual engineering phase would conclude prior to the start of the DEIR documentation process in Q1, 2005; the FEIR would be completed in Q1, 2007. As stated in Section 5.3, 18 months is estimated (rather than 12 months for dam repair/replacement) because of the need to design a pump station and conveyance facilities for a dam enlargement. After the CER is submitted, the SFPUC would commence with the design consultant selection (Q1, 2005). Final design engineering would begin in Q3, 2005, and would have a duration of about 26 months. This estimated duration is 3 months longer than that for the replacement dam due to the increased design work for the pump station and conveyance facilities. SFPUC would begin the selection process for the construction manager in Q3, 2006, so that the construction manager would be available to review the design consultant's 60% submittal. The bid period would begin in Q4, 2007 (bid open 3 months later), with NTP for construction in Q2, 2008. Construction of the replacement dam would be completed in 3 years, with completion in Q2, 2011. The total project duration for the enlarged dam is estimated to be about 9 years, or about one year to 1½ years less than the duration indicated in Version 1.

Exhibit 1
Scope of Work – Task 3

3. Project Delivery Alternatives Evaluation – Given the critical role of Calaveras Dam, we believe that the design and construction of the repair and/or replacement of the dam should be carried out as quickly as practicable. With this in mind, we will develop a step-by step fast track approach (and associated schedule) for completing the environmental review, permitting, design, and construction work. In so doing, we will consider project delivery systems including (1) conventional Design/Bid/Build, and (2) Design/Build approaches to provide the City with alternatives that should be considered in light of the overall schedule. The plan will outline the scope and schedule of each of the permitting and conceptual and final design tasks leading to construction of a project for the same storage capacity or a project with expanded storage capacity.

For the design related steps, we will outline the process, schedule and anticipated deliverables for:

- *Geotechnical investigations*
- *Hydrology and hydraulics studies*
- *Borrow source evaluations*
- *Development of design criteria*
- *Development of conceptual-level seismic strengthening alternatives*
- *Approaches to operation of reservoir during construction*
- *Development of construction cost estimates and schedules*
- *Development of Preliminary Design Report*
- *Selection of preferred alternative*
- *Development of Final Design Documents*
- *Development of Final Construction Cost Estimates and Schedules*
- *Approaches to Risk Management*
- *Approaches to Value Engineering reviews*
- *Design review meetings and coordination with DSOD*
- *Design review meetings with City*
- *Design review by construction staff*

Our deliverable for this task will be a technical memorandum summarizing our evaluation of the project delivery alternatives, and the engineering program required to implement the project as described above. One project meeting is assumed for this task.

1	Planning (SFPUC)	42 mons
2	Conceptual Engineering Consultant Selection	6 mons
3	Environmental Consultant Selection	6 mons
4	CIP Programmatic Environmental Documentation [not used]	0 mons
5	Habitat Conservation Plan (HCP) [not used]	0 mons
6	Environmental Baseline Data Collection	12 mons
7	Environmental Documentation & Review:	24 mons
7.1	DEIR	18 mons
7.2	FEIR	6 mons
8	Environmental Permitting Process	38 mons
9	Public Participation:	72 mons
9.1	Design Phase	41 mons
9.2	Construction Phase	31 mons
10	Conceptual Engineering	12 mons
11	Design Consultant Selection	6 mons
12	Final Design/ Bid & Contract Documents:	54 mons
12.1	30% Design	9 mons
12.2	60% Design	6 mons
12.3	90% Design	5 mons
12.4	Final Design	3 mons
12.5	Design Support During Construction	30 mons
13	Bid Period	3 mons
14	Award/ NTP	3 mons
15	Construction Manager Selection	6 mons
16	Construction Management	39 mons
17	Construction	24 mons
18	Project Management (SFPUC)	96 mons
19	Division of Safety of Dams Review/ Approvals:	81 mons
19.1	Conceptual Engineering	3 mons
19.2	30% Design	3 mons
19.3	60% Design	3 mons
19.4	90% Design	3 mons
19.5	Approval to Construct	1 mon
19.6	Final Approval	3 mons

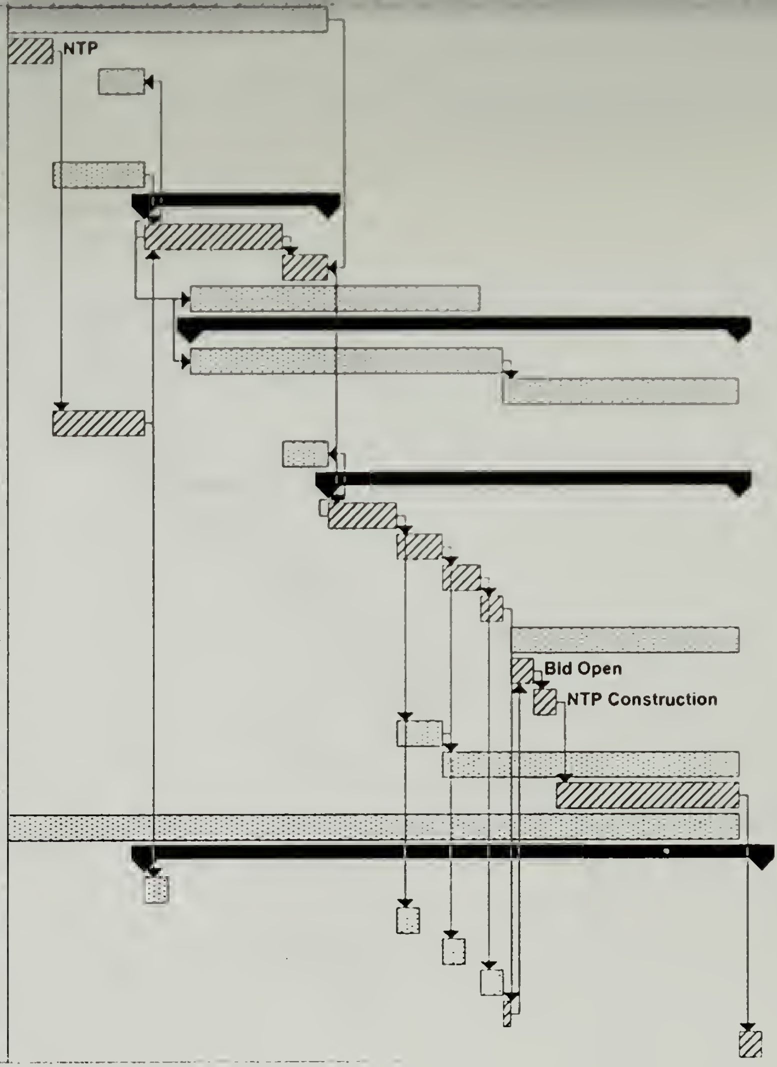


Figure 1
Calaveras Dam Repair/Replacement (Same Storage)
Project Schedule (Version 1): Sequential Engineering & Environmental Review

Task | Milestone | Summary | Critical

Fig. 1_revised02_ Schedule-98.mpp - Fri 1/24/03 3:26 PM

ID No.	Phase	Est. Duration
1	**Planning (SFPUC)**	30 mons
2	**Conceptual Engineering Consultant Selection**	6 mons
3	**Environmental Consultant Selection**	6 mons
4	**CIP Programmatic Environmental Documentation [not used]**	0 mons
5	**Habitat Conservation Plan (HCP) [not used]**	0 mons
6	**Environmental Baseline Data Collection**	12 mons
7	**Environmental Documentation & Review:**	24 mons
7.1	DEIR	18 mons
7.2	FEIR	6 mons
8	**Environmental Permitting Process**	32 mons
9	**Public Participation:**	66 mons
9.1	Design Phase	38 mons
9.2	Construction Phase	28 mons
10	**Conceptual Engineering**	12 mons
11	**Design Consultant Selection**	6 mons
12	**Final Design/ Bid & Contract Documents:**	54 mons
12.1	30% Design	9 mons
12.2	60% Design	6 mons
12.3	90% Design	5 mons
12.4	Final Design	3 mons
12.5	Design Support During Construction	30 mons
13	**Bid Period**	3 mons
14	**Award/ NTP**	3 mons
15	**Construction Manager Selection**	6 mons
16	**Construction Management**	39 mons
17	**Construction**	24 mons
18	**Project Management (SFPUC)**	78 mons
19	**Division of Safety of Dams Review/ Approvals:**	63 mons
19.1	Conceptual Engineering	3 mons
19.2	30% Design	3 mons
19.3	60% Design	3 mons
19.4	90% Design	3 mons
19.5	Approval to Construct	1 mon
19.6	Final Approval	3 mons

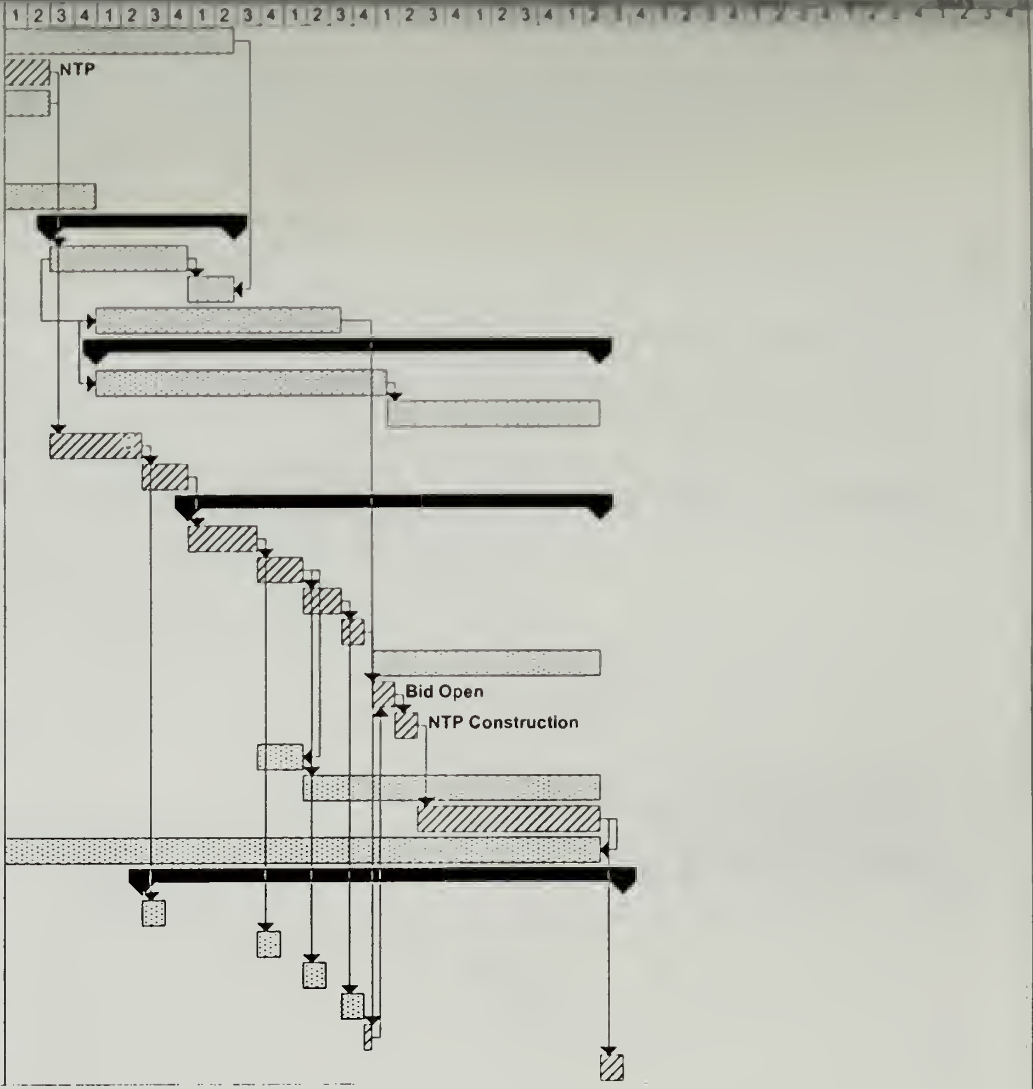


Figure 2
Calaveras Dam Repair/Replacement (Same Storage)
Project Schedule (Version 2): Concurrent Engineering & Environmental Review

Task | Milestone | Summary | Critical

Fig. 2_revised02_ Schedule-98.mpp - Fri 1/24/03 3:26 PM

Phase	Est. Duration
Planning (SFPUC)	48 mons
Conceptual Engineering Consultant Selection	6 mons
Environmental Consultant Selection	6 mons
CIP Programmatic Environmenal Documentation	18 mons
Habitat Conservation Plan (HCP) [begins in 2002]	24 mons
Environmental Baseline Data Collection	18 mons
Environmental Documentation & Review	24 mons
DEIR	18 mons
FEIR	6 mons
Environmental Permitting Process	41 mons
Public Participation:	87 mons
Design Phase	53 mons
Construction Phase	34 mons
Conceptual Engineering	18 mons
Design Consultant Selection	6 mons
Final Design/ Bid & Contract Documents:	69 mons
30% Design	9 mons
60% Design	8 mons
90% Design	6 mons
Final Design	3 mons
Design Support During Construction	42 mons
Bid Period	3 mons
Award/ NTP	3 mons
Construction Manager Selection	6 mons
Construction Management	52 mons
Construction	36 mons
Project Management (SFPUC)	117 mons
Division of Safety of Dams Review/ Approvals:	96 mons
Conceptual Engineering	3 mons
30% Design	3 mons
60% Design	3 mons
90% Design	3 mons
Approval to Construct	1 mon
Final Approval	3 mons

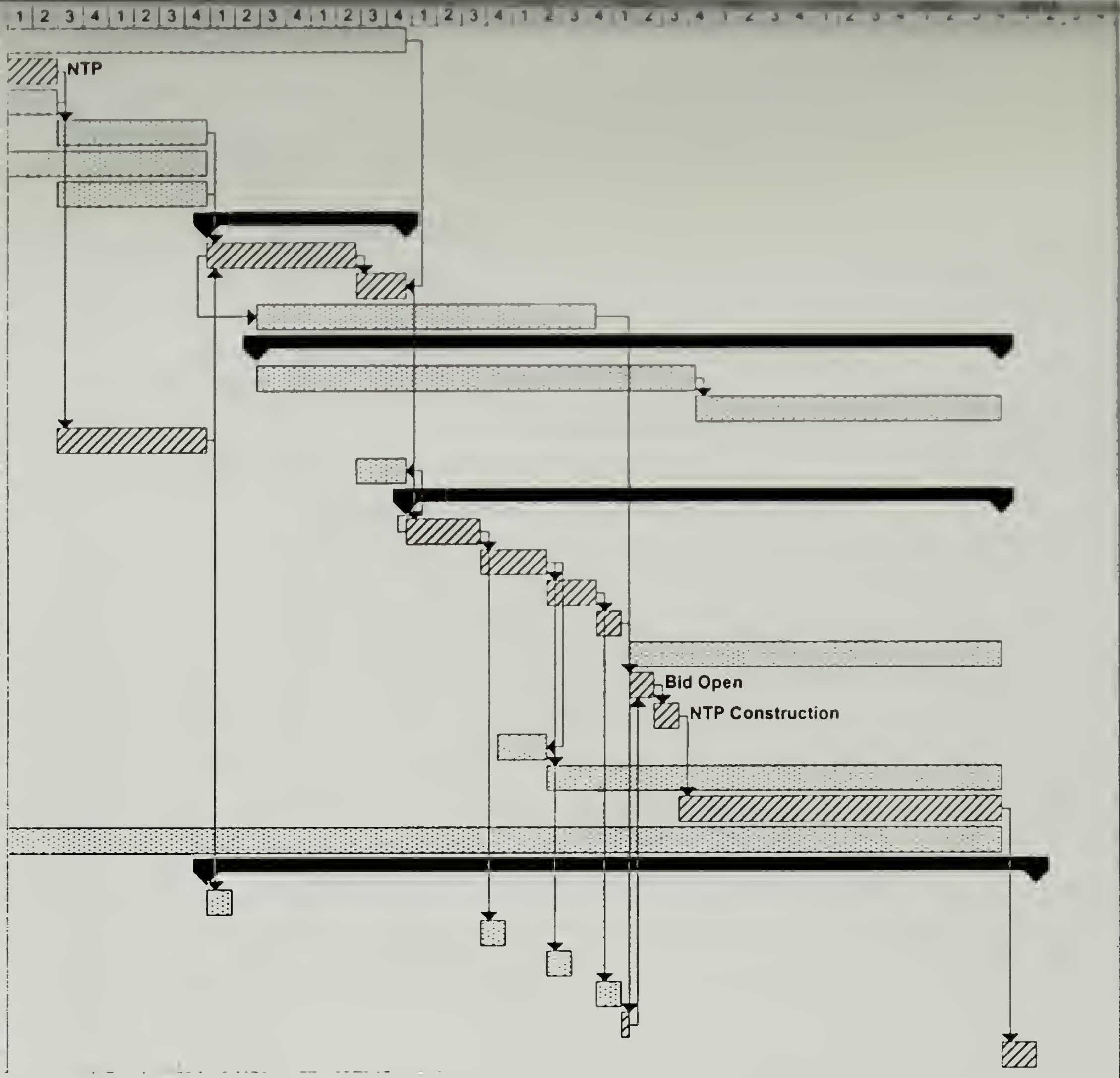


Figure 3
Calaveras Dam Enlargement
Project Schedule (Version 1): Sequential Engineering & Environmental Review

Fig. 3_revised02_ Schedule-98.mpp - Fri 1/24/03 2:31 PM

ID No.	Phase	Est. Duration
1	**Planning (SFPUC)**	48 mons
2	**Conceptual Engineering Consultant Selection**	6 mons
3	**Environmental Consultant Selection**	6 mons
4	**CIP Programmatic Environmenal Documentation**	18 mons
5	**Habitat Conservation Plan (HCP) [begins in 2002]**	24 mons
6	**Environmental Baseline Data Collection**	18 mons
7	**Environmental Documentation & Review**	24 mons
7.1	DEIR	18 mons
7.2	FEIR	6 mons
8	**Environmental Permitting Process**	27 mons
9	**Public Participation:**	85 mons
9.1	Design Phase	42 mons
9.2	Construction Phase	43 mons
10	**Conceptual Engineering**	18 mons
11	**Design Consultant Selection**	6 mons
12	**Final Design/ Bid & Contract Documents:**	69 mons
12.1	30% Design	9 mons
12.2	60% Design	8 mons
12.3	90% Design	6 mons
12.4	Final Design	3 mons
12.5	Design Support During Construction	42 mons
13	**Bid Period**	3 mons
14	**Award/ NTP**	3 mons
15	**Construction Manager Selection**	6 mons
16	**Construction Management**	52 mons
17	**Construction**	36 mons
18	**Project Management (SFPUC)**	99 mons
19	**Division of Safety of Dams Review/ Approvals:**	78 mons
19.1	Conceptual Engineering	3 mons
19.2	30% Design	3 mons
19.3	60% Design	3 mons
19.4	90% Design	3 mons
19.5	Approval to Construct	1 mon
19.6	Final Approval	3 mons

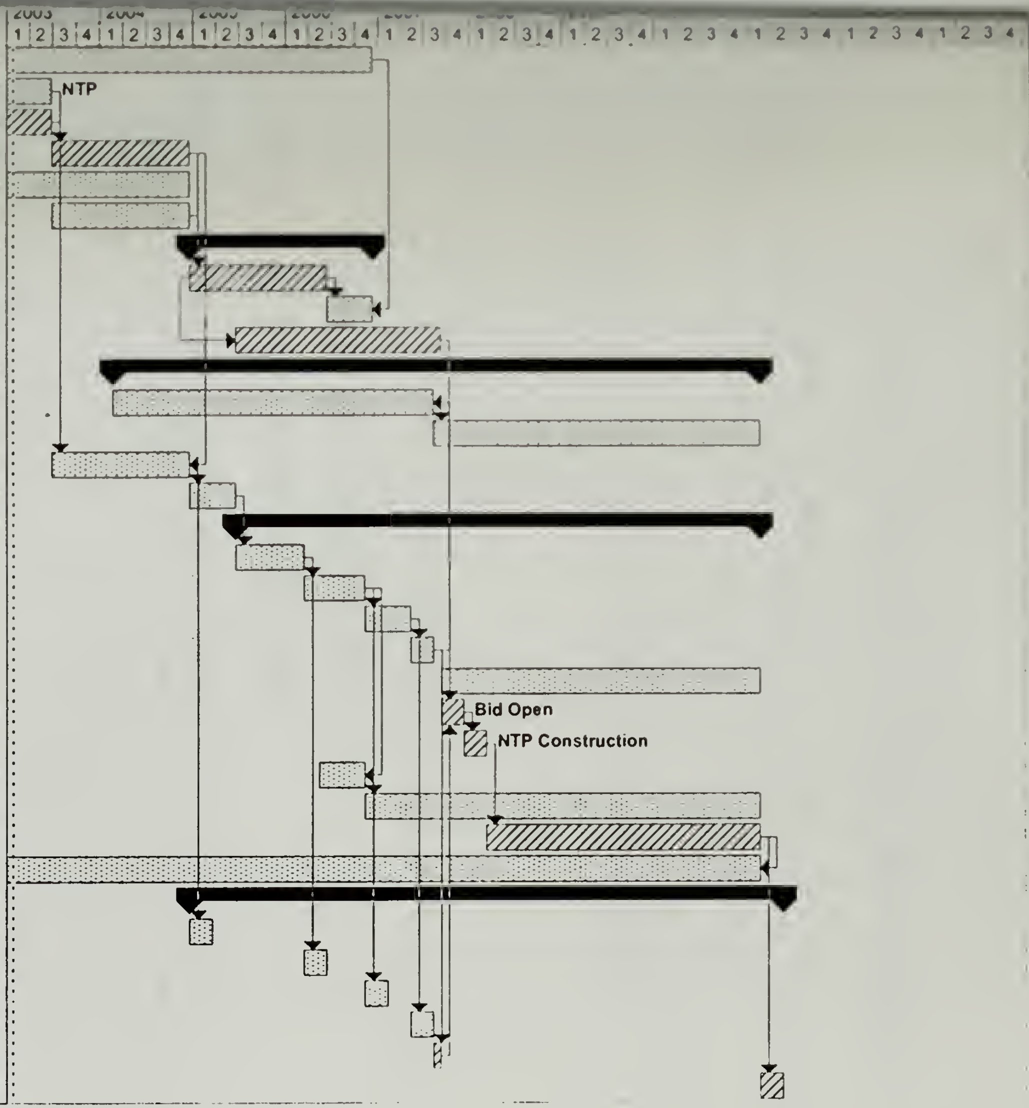


Figure 4
Calaveras Dam Enlargement
Project Schedule (Version 2): Concurrent Engineering & Environmental Review

Task | Milestone | Summary | Critical

Fig. 4_revised02_ Schedule-98.mpp - Fri 1/24/03 2:32 PM

APPENDIX A
PHASE 1: CONCEPTUAL ENGINEERING REPORT

2 **Task 1: Development of Design Criteria**
Scope: Develop basic design criteria for selection of concepts to repair or replace Calaveras Dam. Criteria will include the following general topics:

- Reservoir operation levels during construction and long-term operations
- Embankment and foundation material properties for analysis
- Stability factors of safety
- Seismic design criteria
- Design storm and flood
- Freeboard requirements
- Outlet works hydraulic and operation criteria, including reservoir emptying criteria
- Conveyance and water quality criteria

Deliverables: Design criteria memorandum

(3) **Task 2: Investigation Work Plans for Environmental Clearance**
Scope: Prepare work plans for the proposed geotechnical investigations to assist the environmental representative in evaluating the potential impacts of the investigation. The work plan shall include a map showing the location of the proposed access roads and investigation (i.e. borings, new roads, test pits, fault trenches, geophysical surveys, etc.), a plan indicating the work area and limit of disturbance, site photographs, and a brief description of the investigation program. The Consultant shall meet with the environmental representative in the field as needed to discuss the field investigation procedures, stake exploration locations and make adjustments to exploration locations as required.

Deliverables: Work plans for environmental clearance

Task 3: Foundation Investigations
(4) Scope: Exploration plan for the dam sites includes core drilling, water pressure testing and geophysics. Conduct aerial photography to generate orthophotographs and topographic maps of the damsite area extending from the existing dam downstream for about one mile. Locate the borings on a site plan and indicate their purpose and estimated depths. The borings should be located to cover the area of the potential replacement dams. Indicate laboratory testing on rock samples.

After review and approval of the exploration plan by SFPUC and DSOD, the exploration work will begin. All boring and geophysical test locations (coordinates) and elevations shall be surveyed. Upon completion of the work, prepare a Foundation Geotechnical Data Report including logs of borings, geophysical data, and laboratory testing results.

Deliverables:

- Topographic maps and orthophotographs of damsite area.

- Exploration plan (map) and technical memorandum on exploration objectives and standards to be used.
- Foundation Geotechnical Data Report

5 **Task 4: Borrow Source Evaluations**
Scope Review data and information on borrow materials availability within the site area, including within the reservoir. Exploration of proposed quarries and borrow areas includes core drilling and geophysics. Locate bucket auger and/or test pits in the soil borrow areas. Research, document and summarize information on hazardous waste contamination at the Calaveras Test Site at the south end of the reservoir. Prepare laboratory test program for soil and rock samples.

After review and approval of the exploration plan by SFPUC and DSOD, the exploration work will begin. All boring, test pit, and geophysical test locations (coordinates) and elevations shall be surveyed. Upon completion of the work, prepare a Borrow Materials Geotechnical Data Report including logs of borings, geophysical data, and laboratory testing results.

Deliverables:
- Exploration plan (map) and technical memorandum on exploration objectives and standards.
- Borrow Materials Geotechnical Data Report.

6 **Task 5: Fault Investigations**
Scope:

Fault investigations are required to locate any faults in the dam site foundation and to assess their recency of faulting and if possible their rate of activity. This work shall include reviewing geologic reports, data and maps, ground reconnaissance, and excavating trenches across suspected faults in the foundation. Consideration will also be given to the use of seismic refraction surveys to locate potential fault traces. All trench locations (coordinates) and elevations shall be surveyed. If faults are exposed in any of the trenches, the trench walls shall be logged.

Deliverables: Technical memorandum on fault investigation results and characterization.

7 **Task 6: Hydrology and Hydraulics Studies**
Scope: Develop design storm and flood inflow hydrograph. Route inflow hydrograph through spillway. Various spillway widths and freeboard combinations will need to be evaluated to assess appropriate combinations.

Deliverables: Technical memorandum on results of hydrologic and hydraulic analyses.

8 **Task 7: Environmental Considerations**
Scope:
- Identify environmental considerations such as area of foundation area and borrow and quarry areas needed.

- Identify sensitive/endangered species based on published information.
- Identify additional inundation areas.
- Discuss methods of reducing impacts resulting from borrow and quarry operations.
- Prepare estimates of truck traffic haul load intensity.
- Comment on relative environmental impacts between the various alternatives.

Deliverables: Technical memorandum on environmental considerations.

Task 8: Development of Conceptual-Level Seismic Strengthening Alternatives
Scope: Prepare conceptual level ("10%") designs of the repair and replacement alternatives. Evaluation of the repair of the existing dam will include review of the Olivia Chen Consultants (OCC, 2002) report on the deformation analysis of the existing dam. Develop alternative concepts for repair, evaluate their technical feasibility, and prepare conceptual drawings of the technically viable alternatives. Develop rationale for short-listing technically viable alternatives. Perform stability analyses that demonstrate the technical viability of the repair alternatives.

Replacement dams and appurtenant works shall be designed for (1) raise in two stages to an ultimate reservoir elevation of about 900 and (2) to this elevation in one stage. For the staged approach, the first stage shall be at elevation 750 (maximum water surface prior to restriction). Develop alternative concepts, evaluate their technical feasibility, and prepare conceptual drawings of the technically viable alternatives. Develop rationale for short-listing technically viable alternatives. Perform stability analyses that demonstrate the technical viability of the alternatives.

Deliverables: Technical memorandum of the alternatives evaluation. The memorandum shall contain discussions of the alternatives considered, rationale for short listing, and conceptual level drawings of the plan and sections of the short-listed alternatives.

Task 9: Conveyance Facilities
Scope: Conduct conceptual studies for conveyance facilities for the enlarged Calaveras Reservoir. Analyses will address pipeline lengths and sizes, pumping requirements, and pump station location. These studies will include consideration of geotechnical conditions, traffic and utilities. This task also includes preparation of conceptual plans for the pump station facility.

Deliverables: Technical memorandum on conveyance facilities.

Task 10: Operation of Reservoir during Construction
Scope: Present and discuss reservoir operation plans during construction to maximize water availability. Estimate duration when reservoir will need to be emptied.

Deliverables: Technical memorandum on reservoir operation during construction.

Task 11: Road and Utility Relocation
Scope: Prepare conceptual design for the portion of Calaveras Road that will need to be relocated for the enlarged reservoir. The design shall include road layout and alignment plans, with estimated right-of-way requirements. Also, identify the utilities that may need to be relocated for an enlarged reservoir.

Deliverables: Technical memorandum on road and utility relocation.

Task 12: Development of Cost Estimates and Schedules, and Constructibility Reviews
Scope: Prepare construction cost estimates for the technically viable alternatives. Costs will include all project components facilities such as hydraulic structures, conveyance systems, pumping plants, and road and utility relocations. Estimated costs for design engineering and construction management are also required. Estimate the additional operation costs for the enlarged Calaveras Reservoir.

The cost estimates shall be prepared to show all major line items. The basis and assumptions of the cost estimates shall be documented. Include line items for final design engineering and construction management.

Schedules shall be prepared showing all main construction items as identified in the cost estimate. The critical path shall be identified. A technical memorandum shall be prepared that discusses productivities and other assumptions in the schedule.

Deliverables: Construction cost and schedule technical memorandum, with basis and assumptions.

Task 13: Development of Conceptual Engineering Report
Scope: The results for the studies in the above tasks (TM's) shall be summarized in a conceptual engineering report. An executive summary shall be included.

Deliverables: Draft and final versions of the Conceptual Engineering Report

Task 14: Project Management and Meetings with SFPUC
Scope: Meet with SFPUC monthly, and as needed, to discuss project status and progress and forthcoming work to be done. Discuss issues to be resolved and proposed resolutions.

Deliverables:
- Meeting summaries indicating project status and work to be done, with action items indicated.
- Monthly progress reports.

Task 15: Design Review Workshops with SFPUC
Scope: Meet with SFPUC periodically to review and develop resolutions for significant design issues.

Deliverables: Workshop summaries indicating decisions reached on significant design issues.

15 **Task 16: Design Review Meetings and Coordination with DSOD**
Scope: Meet and coordinate with DSOD to get their input on design issues. Milestone meetings with DSOD include, but are not limited to, review of design criteria, exploration planning, and concept development.

Deliverables: Meeting summaries with DSOD.

16 **Task 17: Technical Review Committee Meetings**
Scope: Prepare presentations for and attend Technical Review Committee Meetings.

Deliverables: Presentation materials for Technical Review Committee Meetings.

17 **Task 18: Engineering Support during Preparation for Environmental Documents and Permit Applications.**
Scope: The Conceptual Engineering phase will coincide with the environmental documentation and permitting phase. This work will include supporting the environmental consultants requests for information.

Deliverables: Inputs to the environmental documentation, as required by the SFPUC and environmental consultant.

18 **Task 19: Selection of Preferred Alternative (SFPUC)**
Scope: Based on the work indicated in the above tasks, SFPUC will meet with the design engineering consultant to review findings and select the preferred alternative to repair or enlarge Calaveras Dam. The rationale for selection of the preferred alternative shall be included in the Conceptual Engineering Report.

Deliverables: Documentation on selection of the preferred alternative to repair or enlarge Calaveras Dam.

APPENDIX B
PHASE 2: FINAL DESIGN

Task 1: Investigation Work Plans for Environmental Clearance
Scope: Prepare work plans for the proposed geotechnical investigations to assist the environmental representative in evaluating the potential impacts of the investigation. The work plan shall include a map showing the location of the proposed access roads and investigation (i.e. borings, new roads, test pits, fault trenches, geophysical surveys, etc.), a plan indicating the work area and limit of disturbance, site photographs, and a brief description of the investigation program. The Consultant shall meet with the environmental representative in the field as needed to discuss the field investigation procedures, stake exploration locations and make adjustments to exploration locations as required.

Deliverables: Work plans for environmental clearance

Task 2: Final Foundation Investigation
Scope: This final foundation investigation will build upon and fill in the data gaps from the Phase 1 investigation program.

Prepare a final exploration plan for the selected dam site that includes core drilling, water pressure testing and geophysics. Locate the borings on a site plan and indicate their purpose and estimated depths. Indicate laboratory testing on rock samples.

After review and approval of the exploration plan by SFPUC and DSOD, the exploration work will begin. All boring and geophysical test locations (coordinates) and elevations shall be surveyed. Upon completion of the work, prepare a Foundation Geotechnical Data Report that builds on the report that was prepared for Conceptual Engineering (Phase 1). The report shall include logs of borings, geophysical data, and laboratory testing results.

Deliverables:

- Exploration plan (map) and technical memorandum on exploration objectives and standards to be used.
- Foundation Geotechnical Data Report

Task 3: Final Borrow Source Investigations
Scope: This final borrow investigation will build upon and fill in the data gaps from the Phase 1 investigation program.

Prepare a final exploration plan of proposed quarries and borrow areas. Locate core drilling and geophysics in the quarries. Locate bucket auger and/or test pits in the soil borrow areas. Prepare laboratory test program for soil and rock samples, as stated in Task 2, Phase 1.

After review and approval of the exploration plan by SFPUC and DSOD, the exploration work will begin. All boring, test pit, and geophysical test locations (coordinates) and elevations shall be surveyed. Upon completion of the work, prepare a Borrow Materials

Geotechnical Data Report that builds on the report that was prepared for Conceptual Engineering (Phase 1). The report shall include logs of borings, geophysical data, and laboratory testing results.

Deliverables:
- Exploration plan (map) and technical memorandum on exploration objectives and standards.
- Borrow Materials Geotechnical Data Report.

Task 4: Engineering and Analyses of Selected Alternative
Scope:

- Update design criteria for the selected alternative.
- Develop design seismic ground motions.
- Perform stability and seismic deformation analyses on the selected alternative.
- Perform hydraulic analyses for the spillway and outlet works.
- Update hydraulic analyses for the conveyance system.

Deliverables: Prepare the following technical memoranda:
- Stability and deformation analyses.
- Spillway hydraulic analyses
- Outlet works and hydraulic analyses
- Conveyance system hydraulic analyses.

Task 5: Preliminary Design Drawings of Selected Alternative and Cost Estimate
Scope: Preliminary (30%) construction drawings shall be prepared using AUTOCADD, based on SFPUC standards. Construction drawings shall show the plans and sections and main details of the site facilities. Prepare a preliminary construction cost estimate from the 30% drawings.

Deliverables:
- 30% design drawings
- 30% cost estimate

Task 6: Contract Packaging
Scope: Evaluate contract packaging strategies including single contract and multiple contract packages for separate facilities. Discuss the pros and cons of each strategy and recommend the preferred approach.

Deliverables: Technical memorandum on contract packaging.

Task 7: Development of Final Design Documents (60%, 90% and final levels) Drawing and Specifications
Scope: Consultant shall submit construction plans and specifications at 60%, 90% and final levels. All comments shall be addressed and incorporated in the next phase of design.

Technical specifications shall be prepared in the Construction Specification Institute (CSI) format. SFPUC will provide general conditions for use in this project. Consultant shall prepare Special Conditions of the Contract.

Deliverables: Specifications and half size drawings at 60% and 90% completion and both half size and full size drawings at completion of final (100%) design.

- Two (2) sets of drawings, specifications and cost estimates at 60% and 90% level
- Ten (10) sets of hard copies and one (1) set of reproducible set of drawings and specifications at final level
- One electronic copy of drawing and specifications in CD at final level.

Task 8: Development of Final Construction Cost Estimates and Schedules
Scope: Prepare engineer's estimate including a schedule of quantities that list all bid items and associated unit costs for the various work items required to complete the work as shown on the final plans. Also prepare a construction schedule with work breakdown structures that outlines the duration, milestone dates, and interdependencies of the various tasks to complete the work. Schedule shall be prepared using latest version of "SureTrak" project management or Microsoft Project software program.

Deliverables:
Five (5) hard copies and one (1) electronic copy (in a floppy disk) of the final construction cost estimate and construction schedule

Task 9: Approaches to Risk Management
Scope: Prepare a technical memorandum that describes the potential risks and ways to manage and mitigate the risks associated with the proposed work. Such risks include but are not limited to availability and suitability of construction materials, field conditions, and contractual issues. Describe risk management provisions for inclusion in the Contract Documents.

Deliverables: Technical memorandum on risk management.

Task 10: Approaches to Value Engineering Reviews
Scope: Prepare a technical memorandum describing the approaches for conducting value engineering review to evaluate the costs and functions of design components. Describe value engineering provisions for inclusion in the Contract Documents.

Deliverables: Technical memorandum on value engineering.

Task 11: Bid Period Services
Scope: Assist SFPUC during solicitation of bids for the work including the following activities:

- Attending the pre-bid meeting
- Answering bidders' questions
- Preparing drawing and technical specification modifications for addenda

Deliverables:

- Drawing and technical specification modifications for addenda

Task 12: Project Management and Meetings with SFPUC
Scope: Meet with SFPUC monthly, and as needed, to discuss project status and progress and forthcoming work to be done. Discuss issues to be resolved and proposed resolutions. These meetings will include SFPUC design and construction staff.

Deliverables:

- Meeting summaries indicating project status and work to be done, with action items indicated.
- Monthly progress reports.

Task 13: Design Review Meetings and Coordination with DSOD
Scope: Meet and coordinate with DSOD to get their input on design. Milestones include but are not limited to final design criteria, final exploration planning, and design development at 30%, 60%, 90% and final levels.

Deliverables: Meeting summaries with DSOD.

Task 14: Technical Review Committee Meetings
Scope: Prepare presentations for and attend Technical Review Committee Meetings.

Deliverables: Presentation materials for Technical Review Committee Meetings.

Task 15: Engineering Support for Permits
Scope: Support the environmental consultant to obtain project permits.

Deliverables: Inputs to the environmental consultant for permitting.

APPENDIX C
PHASE 3: CONSTRUCTION MANAGEMENT

Task 1: Pre-construction Activities
Scope:
Provide assistance to SFPUC for:
- Pre-award meeting.
- Partnering meeting and partnering process.
- Pre-construction meeting to review contractor's schedule and general performance of the work.
- Construction management and quality assurance (QA) manual that defines QA and testing process, and roles and responsibilities of the various team member organizations.

Deliverables:
- Materials for pre-award, partnering, and pre-construction meetings
- Construction Management and Quality Assurance Manual

Task 2: Field Engineering
Scope: Support the SFPUC construction management team by performing the following field engineering and associated work to ensure that the construction work complies with the project plans, specifications, and the design intent.

- Review submittals and Request for Information (RFI) and prepare responses
- Communicate and coordinate with SFPUC and DSOD and prepare communication records
- Coordinate and conduct construction meetings with contractor and prepare meeting minutes
- Perform daily construction monitoring documenting the progress of the work and all pertinent information
- Set up document controls
- Set up project controls including cost and schedule control.

This task also includes monitoring the construction work for environmental compliance, which will be performed by the environmental consultant.

Deliverables: Provide one copy of the following.
- Responses to submittals and RFI
- Meeting minutes
- Communication records with DSOD
- Daily construction reports
- Weekly status reports
- Critical Action Reports
- Job photographic files
- Cost reports
- Schedule reports.

Task 3: Inspection and Testing
Scope: Support the SFPUC construction management team by performing daily inspection of the work and perform quality assurance testing on materials as indicated in the Specifications. Material testing shall include both field and laboratory testing.

Deliverables:
- Quality assurance testing reports including field and lab testing results.

Task 4: Contract Administration
Scope: Support the SFPUC construction management team by performing contract administration work that includes the following:
- Review and recommend for action, progress payment requests
- Review, administer, and negotiate Contractor's change orders and provide comments and recommendation to SFPUC
- Prepare field letters and field orders for Contractor's action
- Record, process, negotiate, and close out changes and claims
- Review and comment on the Contractor's work progress and CPM schedule and inform SFPUC of any delay or potential problem and potential resolutions
- Review and track project costs. Prepare cost reports showing approved budget, expenses, percent complete, budget remaining, variance, and projected cost to complete
- Review and track project progress. Prepare schedule reports showing planned duration, target completion dates, percent complete and projected completion dates
- Review and conduct final inspection of work and prepare final punchlist
- Prepare required close out documentation upon completion of contract work and approve final payments

Deliverables:
- Field letters and orders
- Summary of review and recommendation for change order and claims
- Change order logs
- Punchlists
- Closeout documents

Task 5: Office Engineering Support
Scope:
- Provide, on an as-needed basis, design modification and support to accommodate field conditions and contractor's request.
- Prepare monthly progress report, recording progress and events that have taken place, problem encountered, test performed and test results. The report also compares actual performance of project work as measured against the latest approved schedule. Work anticipated for the next month is also summarized.
- Coordinate with DSOD for all required inspection and notification during the process of construction and document all communication.

- Prepare record drawings of construction and operations and maintenance manuals.

<u>Deliverables:</u>

- Design modification details;
- Monthly progress reports;
- Communication records with DSOD.
- Presentation materials for Technical Review Committee Meetings
- Record drawings of construction
- Operations and maintenance manuals.

SECTION 5

URS

Date: December 27, 2002

To: Patty Mallett, SFPUC

From: Steve Ritchie

Subject: *Calaveras Dam Evaluations – Contingency Action Plan*
Task 4 - Environmental Compliance Strategy and Permit Guide

Repair or replacement of Calaveras Dam may require a number of permits from various agencies as described in Section 6 of this memorandum. In summary, those permits include:

- **U.S. Army Corps of Engineers** – Clean Water Act Section 404 permit
- **Regional Water Quality Control Board** – Clean Water Act Section 401 Water Quality Certification and potential modification of Site Cleanup Requirements (Quantic site)
- **State Water Resources Control Board** – NPDES general Stormwater permit for construction
- **Department of Fish and Game** – Streambed Alteration Agreement
- **National Marine Fisheries Service** – Endangered Species Act consultation
- **U.S. Fish and Wildlife Service** – Endangered Species Act consultation
- **State Historic Preservation Office** – National Historic Preservation Act review
- **Counties of Alameda and Santa Clara** – Potential local permits

In addition a permit to construct will be needed from the Department of Water Resources, Division of Safety of Dams. However, that is not normally considered an "environmental" permit and will not be discussed in this memorandum.

This memo will lay out the framework of an environmental compliance strategy. A more detailed strategy should be developed by the SFPUC at the earliest possible time so that environmental compliance can be effectively achieved for the project.

1.0 COMPLIANCE STRATEGY

The basic components of the strategy for compliance for the Calaveras Dam Project are:

- Timely preparation of the Calaveras Dam Project Environmental Impact Report (EIR)
- Coordinated preparation of the Calaveras Dam Project EIR with preparation of a Programmatic EIR
- Coordinated preparation of the Calaveras Dam Project EIR with development of an Alameda Creek Watershed Habitat Conservation Plan
- Early, coordinated consultation with the State and Federal regulatory agencies

- Regular communication with the State and Federal regulatory agencies throughout the environmental review process
- Public outreach during the conceptual engineering and environmental review processes

Each of these components is discussed briefly below.

2.0 CALAVERAS DAM PROJECT EIR

Obtaining the necessary environmental permits will be tied closely to the preparation of documents for compliance with the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). For the Calaveras Dam Project, an EIR will likely be required for compliance with CEQA and an Environmental Assessment will likely be required for compliance with NEPA. These disclosure documents will provide the basis for the permits described in Section 6 of this memo. Alternative schedules for preparation of the EIR are included in each of the project delivery alternatives described in the Task 3 technical memorandum.

3.0 PROGRAMMATIC EIR AND HABITAT CONSERVATION PLAN

There are two other efforts being considered by the SFPUC that are closely related to and will have an effect on the Calaveras Dam Project. These efforts are the preparation of a Programmatic EIR for the SFPUC's Capital Improvement Program (CIP) and the preparation of a Habitat Conservation Plan (HCP) for projects in the Alameda Creek watershed.

The SFPUC is considering development of a Programmatic EIR to determine potential environmental impacts of of its CIP, particularly related to projects which have the potential to increase the water supply available to the SFPUC and its customers. The projects could include:

- San Joaquin Pipeline No. 4 (hydraulic capacity)
- Calaveras Dam Replacement (enlargement)
- Irvington Tunnel Alternatives
- Bay Division Pipelines - Hydraulic Capacity Upgrade

The advantage of a Programmatic EIR is that potential impacts such as growth inducement can be assessed collectively for the projects instead of each project bearing the burden of a system-wide evaluation and analysis. Project specific EIRs would then be tiered from the Programmatic EIR, taking advantage of the unified analysis provided in it. This could have advantages for the Calaveras Dam Project if enlargement is the selected alternative. The Programmatic analysis would probably not be necessary if replacement without a capacity increase is the selected project. Only a project specific environmental document would be needed.

The SFPUC also is commencing work on preparation of an HCP for projects within the Alameda Creek watershed. Similar to the Programmatic EIR, the development of an HCP allows for the resolution of Endangered Species Act compliance issues for projects collectively rather than individually. The result should be a plan that benefits the environment while smoothing the regulatory process for individual projects. Calaveras Dam is probably the most significant construction project contained in the CIP that is in the Alameda Creek watershed. This is true regardless of whether the Calaveras Dam Project is a repair or replacement project. The HCP development could be used for Endangered Species Act compliance for the Calaveras Dam Project. If it is, the HCP will need to be closely integrated with the permitting process for the Calaveras Dam Project whichever alternative is selected. If it is not, coordination will still be necessary to develop an appropriate mitigation package for the Calaveras Dam Project.

4.0 AGENCY CONSULTATION AND COMMUNICATION

Early consultation with State and Federal permitting agencies is a key to a successful project. For the Calaveras Dam Project, a good approach would be to establish a working group of agency representatives early in project development. The group would regularly meet with the SFPUC through the pre-design and design phases to identify and resolve data needs and issues. Such a working group would help to ensure that there are no surprises late in the permitting process. This type of consultation effort could be formally established via an MOU with stated procedures of operation, as well as identification of roles and responsibilities of the participating agencies.

5.0 PUBLIC OUTREACH

It would be appropriate to develop a public outreach effort early in the project. The purpose of the effort would be to inform the public about the project and obtain their feedback regarding the project as the project is being developed

6.0 PERMIT REQUIREMENTS

The permit requirements associated with the list of identified alternatives for Calaveras Dam are described below in the context of each permitting agency. The State and Federal agencies responsible for permitting various aspects of each Calaveras Dam alternative are:

- U.S. Army Corps of Engineers
- Regional Water Quality Control Board
- State Water Resources Control Board
- Department of Fish and Game
- National Marine Fisheries Service
- U.S. Fish and Wildlife Service

- State Historic Preservation Office (potential)

For each of these permitting agencies, the permitting actions are summarized in the following sections.

6.1 U.S. Army Corps of Engineers

A Section 404 Clean Water Act permit must be obtained from the U.S. Army Corps of Engineers (COE) whenever dredging or filling in waters of the U.S. is proposed. The COE has jurisdiction over all surface waters of the U.S., including perennial and intermittent streams (tidal and non-tidal), lakes, ponds, reservoirs, and wetlands. When evaluating permit applications, the COE considers effects on conservation, economics, wetlands, fish and wildlife values, flood hazards, navigation, water quality, and the needs and welfare of people. The Calaveras project site is located within the San Francisco District of the COE.

6.2 Regional Water Quality Control Board

All COE Section 404 permits must receive a Section 401 Clean Water Act Water Quality Certification from the Regional Water Quality Control Board (RWQCB) before they can be issued. The purpose of the Water Quality Certification is to ensure that approval of the 404 permit for dredging and placement of fill will not adversely affect the ability of the water body to meet state water quality standards. State water quality standards consist of both numeric criteria for individual constituents and narrative criteria for specific beneficial uses of the water body. The RWQCB must provide an individual case-by-case Water Quality Certification for each project proposed for coverage under an individual 404 permit.

In addition, the RWQCB issued Site Cleanup Requirements for management of pollutants in the soil and groundwater at the Quantic site located above the upstream end of the existing reservoir. If the reservoir is enlarged, the Site Cleanup Requirements may need to be reviewed dependent on any changes in how the pollutants are managed.

6.3 State Water Resources Control Board

Coverage under the NPDES general stormwater discharge permit for construction activities will be required for the project prior to the start of construction under each of the alternatives (unless fewer than five acres are disturbed under one of the dam repair alternatives). Coverage under this permit is required for all construction activities involving five or more acres of land disturbance or where the area being disturbed, if less than five acres, is part of a larger project affecting more than five acres of land.

6.4 Department of Fish and Game

The California Department of Fish and Game requires a Streambed Alteration Agreement (SAA) for projects that will divert or obstruct the natural flow of water; change the

channel bed, channel or bank of any stream; or propose to use or deposit any material from or into a stream or lake bed. Generally, the notification requirement applies to any work undertaken within the annual high-water mark of a wash, stream, reservoir, or lake that contains or once contained fish and wildlife or supports or once supported riparian vegetation. The SAA (also known as a 1601 agreement) specifies when work can be performed in the reservoir, what erosion control and other measures will be necessary to protect the reservoir, and what mitigation measures will be required after the work is completed.

6.5 National Marine Fisheries Service/U.S. Fish and Wildlife Service

The National Marine Fisheries Service (NMFS) and/or the U.S. Fish and Wildlife Service must perform a Section 7 Endangered Species Act consultation for all projects where an identified threatened or endangered species or species habitat may be present and where Section 404 permit coverage is being sought. If the project affects anadromous fish or species/habitat in tidal waters, this consultation must include NMFS. If the likely presence of any such species is established, mitigation will be required to ensure that the project does not adversely affect their presence and/or habitat. The presence of special status species may affect the timing of the project and the design of management practices to be used for water diversion and reservoir dewatering.

An alternative form of Endangered Species Act compliance could be through the development of an HCP pursuant to Section 10 of the Act. This is normally used for a large number of routine activities such as maintenance that pose a large regulatory burden for both the applicant and the agencies. It could be applied in this instance since the SFPUC is proposing to develop an HCP for the Alameda Creek watershed.

6.6 State Historic Preservation Office

The State Historic Preservation Office will have an opportunity to review and comment on the 404 permit application with respect to compliance with Section 106 of the National Historic Preservation Act.

6.7 Other Local Permits

Other permits or approvals may be necessary to facilitate implementation of the selected alternative, but none have been specifically identified to date.

SECTION 6

URS

Date: January 21, 2003

To: Patty Mallett, SFPUC

From: Mike Forrest, Noel Wong

Subject: *Calaveras Dam Evaluations – Contingency Action Plan*
Task 5 – Project Schedule and Cost Estimates

1.0 Introduction

In accordance with the scope of work outlined in our March 27, 2002, proposal (Exhibit 1), URS prepared this memorandum on project schedule and costs estimates for repair or replacement of Calaveras Dam. The purpose of this memorandum is to assist the SFPUC in planning and scheduling the engineering, environmental, and construction work necessary to implement a successful Calaveras Dam project.

This memorandum presents work schedules for completing the environmental process, permitting, design, and construction phases of the Calaveras Dam work. We have outlined three potential work schedules for projects including replacement or repair of the existing dam and construction of an enlarged dam. For dam replacement/repair, we have considered two work sequence options, one with engineering concurrent with the DEIR, and one with the activities sequential.

This memorandum summarizes the work performed in previous memoranda, namely Technical Evaluation of Conceptual Dam Repair and Replacement Alternatives (Task 2.2) and Project Delivery Alternatives Evaluation (Task 3). As indicated in our Task 2.2 memorandum, three main categories of potential projects are under consideration at this time:

- Repair or replace dam for same reservoir storage (96,850 acre-feet).
- Replace dam for increased reservoir storage (up to 420,000 acre-feet*).
- Replace dam for same storage but with provision for future enlargement (up to 420,000 acre-feet*).

*Note: 420,000 acre-feet storage is the current estimate of the maximum feasible storage. The final enlarged dam project configurations and storage quantities have yet to be determined.

These potential projects formed the basis of the project delivery alternatives evaluation.

2.0 Work Phases

The phases of environmental and engineering work are briefly outlined below.

Environmental Work: Environmental work consists of the habitat conservation plan (HCP), environmental baseline data collection, environmental documentation and review (preparation of DEIR/FEIR), permitting process, and public participation. In addition, for the enlarged reservoir alternative, CIP programmatic documentation will need to be included.

Conceptual Engineering: The principal objective of Phase 1, Conceptual Engineering, is to evaluate the following alternatives:

(1) repair the existing dam
(2) construct a new dam to replace the existing dam, and
(3) construct an enlarged dam.

The Conceptual Engineering Report should recommend a preferred alternative for each of the repair/replacement or enlargement dam alternatives. This phase includes conceptual engineering for the dam, spillway, outlet works, and road relocation. Engineering for the conveyance facilities and for decommissioning of the existing dam, appurtenant works, and the Alameda Creek diversion works would also be needed for the enlarged dam.

The studies for this phase are focused on performing the work required to evaluate the alternatives from technical, constructibility, cost, and schedule aspects. A principal goal of the Phase 1 work will be to obtain concurrence from Division of Safety of Dams (DSOD) on the selected conceptual alternative for either replacing/ repairing or enlarging Calaveras Dam.

Final Design: The principal objective of Phase 2 is full design development for the selected project alternative. The final design will include contract documents, plans, specifications, and related reports. Together these documents will comprise a bidding package with which the SFPUC can advertise and solicit bids for the work. Phase 2 will culminate in review of bids received and assistance to the SFPUC in the selection of a construction contractor.

Construction Management: The principal objective of Phase 3 is to manage and administer the construction contract so that the completed project is in conformance with established project requirements and quality standards, is finished on time, and is done within the SFPUC's allotted budget. The main elements of Phase 3 will include field engineering, inspection and testing, contract administration, and design engineering support, both in the field and from the home office.

3.0 Implementation Schedule

To assist the SFPUC with conceptualizing and planning for the work involved in implementing a Calaveras Dam project, the following four conceptual project schedules were developed in Task 3:

- Dam Repair/Replacement (same storage) - Version 1: sequential engineering and environmental review (Figure 1)

- Dam Repair/Replacement (same storage) - Version 2: concurrent engineering and environmental review (Figure 2)
- Dam Enlargement - Version 1: sequential engineering and environmental review (Figure 3)
- Dam Enlargement - Version 2: concurrent engineering and environmental review (Figure 4).

Schedule Version 1 (Figures 1 and 3) represents sequential engineering and environmental review and is SFPUC's normal approach. In this approach, conceptual engineering would be performed prior to starting the environmental documentation and review process. Final design would begin after completion of the Final Environmental Impact Report (FEIR). It is noted that we have assumed that a Programmatic Environmental Impact Report would not be required for a repair or replacement project for the same storage capacity. Schedule Version 2 (Figures 2 and 4) represents concurrent engineering and environmental review, which is a more aggressive approach. This approach was successfully used for the Contra Cost Water District's Los Vaqueros Project completed in 1997. In this approach, conceptual engineering would be performed concurrently with the environmental documentation and review process. Final design would begin after completion of conceptual design.

The following table summarizes the estimated project completion [quarter (Q) and year] and the estimated total project duration shown on Figures 1 to 4:

Approx. Project Completion/ Project Duration	Dam Repair/Replacement		Dam Enlargement	
	Sequential Eng/Env	Concurrent Eng/Env	Sequential Eng/Env	Concurrent Eng/Env
Project Completion	Q1, 2011	Q3, 2009	Q2, 2013	Q2, 2011
Project Duration (years)	8	7	10	9

As shown above, concurrent engineering and environmental review could result in a project completion about one year to 1½ years before the process that involves sequential engineering and environmental review. The estimated durations shown above are dependent on the length of the environmental impact studies and the environmental permitting process, both of which can potentially take longer time to complete. For that reason, the actual project durations could be longer than shown in these preliminary schedules. Nonetheless it appears that the concurrent engineering and environmental review approach is worth further consideration if SFPUC wishes to expedite the completion of the project.

The preliminary schedules on Figures 1 to 4 show the main phases of the project, the involvement of the SFPUC, DSOD, permitting agencies, and the engineering and environmental consultants, and the interdependencies of the various phases and the critical paths. These schedules are summaries of the more detailed schedules presented in the Task 3 Project Delivery Alternatives Evaluation memorandum.

All durations indicated were roughly estimated based primarily on our prior experience with similar projects. The schedules show estimated times for DSOD approvals at key design phases, although we note that the DSOD involvement will continue from the start of conceptual design through final completion of construction. The environmental permitting process periods shown on the schedules would extend through final design.

4.0 Cost Estimates

In Task 2.2, we developed order of magnitude comparative construction cost estimates for various replacement dam and repair alternatives as follows:

- Dam Repair Alternatives:
    - Buttressing
    - Buttressing with stone column reinforcement
- Dam Replacement and Enlargement Alternatives:
    - Earthfill dam
    - Earth core rockfill dam
    - Concrete–faced rockfill dam
    - Roller compacted concrete dam.

The comparative costs are based on historical cost data for URS' projects over the past six years. The costs do not include costs for pump stations, transmission facilities, or transfer facilities that are needed for reservoir enlargements. Allowances for environmental work, design and construction management were included. Allowances for SFPUC's activities that include planning, project management, land acquisition, and for other items are not included in the cost estimates.

Although repairing the existing dam would have the lowest initial capital cost, this alternative is not likely to meet one of SFPUC's objectives, which is for the dam to remain functional after a major earthquake. For the replacement dam, construction cost estimates in this memorandum are based on the concrete-faced rockfill dam, which may be more appropriate for planning purposes at this stage of the project, as indicated in the Task 2.2 memorandum.

The estimated costs are presented on the schedules, Figures 1 to 4, and are summarized in Table 1 below with the estimated total project durations:

Table 1. Summary of Estimated Costs and Project Durations

Alternative	Reservoir Capacity (acre-feet)	Total Estimated Cost [a]	Estimated Project Duration [b]
Repair existing dam [c]	96,850	$72 million	7 to 8 years (see Figures 1 & 2
Replace dam for same reservoir storage [d]	96,850	$102 million	7 to 8 years (see Figures 1 & 2)
Replace dam for increased reservoir storage [d]	420,000	$290 million [e]	9 to 10 years (see Figures 3 & 4)

(a) Includes environmental, engineering, construction management, and construction components. Excludes SFPUC's costs. See Task 2.2 memorandum for breakdown of costs.

(b) Shorter durations for each alternative are for concurrent engineering and environmental review. Longer durations for each alternative are for sequential engineering and environmental review.

(c) Upstream and downstream buttresses alternative. This alternative is not likely to meet the objective for the dam to remain functional after a major earthquake.

(d) Concrete-faced rockfill dam alternative.

(e) This cost does not include costs for pump stations, transmission facilities, or transfer facilities.

URS

Exhibit 1
Scope of Work – Task 5

5. Project Schedule and Costs Estimates – We will develop an overall schedule for all the environmental, engineering and construction activities associated with a project having the same storage capacity or a project with expanded storage capacity. Budget level cost estimates will also be developed for all the activities. Depending on the needs of the City's Capital Improvement Program, additional evaluations and inputs on schedule and costs can be developed. Our objective is to assist the City to adequately plan for the amount and timing of funds required to complete the project. This information will be required in developing the plan of actions for repair and/or replacement of the dam that will be submitted to the DSOD. In this regard, the schedule should be realistic and yet aggressive enough to gain the confidence of the DSOD in terms of the approval of an interim operations plan.

Our deliverable for this task will be a technical memorandum summarizing our work related to the project schedules and cost estimates. A simpler schedule for the project that the City decides to pursue will then be prepared for submittal to the DSOD. One project meeting is assumed for this task.

ID No.	Phase	Est. Duration	Est. Cost ($ million)
1	Planning (SFPUC)	42 mons	
2	Conceptual Engineering Consultant Selection	6 mons	
3	Environmental Consultant Selection	6 mons	
4	CIP Programmatic Environmental Documentation [not used]	0 mons	
5	Habitat Conservation Plan (HCP) [not used]	0 mons	?
6	Environmental Baseline Data Collection	12 mons	?
7	Environmental Documentation & Review	24 mons	$2
8	Environmental Permitting Process	38 mons	(cost included in task 7)
9	Public Participation	72 mons	(cost included in task 7)
10	Conceptual Engineering	12 mons	$3
11	Design Consultant Selection	6 mons	
12	Final Design/ Bid & Contract Documents	54 mons	$5
13	Bid Period	3 mons	
14	Award/ NTP	3 mons	
15	Construction Manager Selection	6 mons	
16	Construction Management	39 mons	$12
17	Construction	24 mons	$80
18	Project Management (SFPUC)	96 mons	?
19	Division of Safety of Dams Review/ Approvals	81 mons	

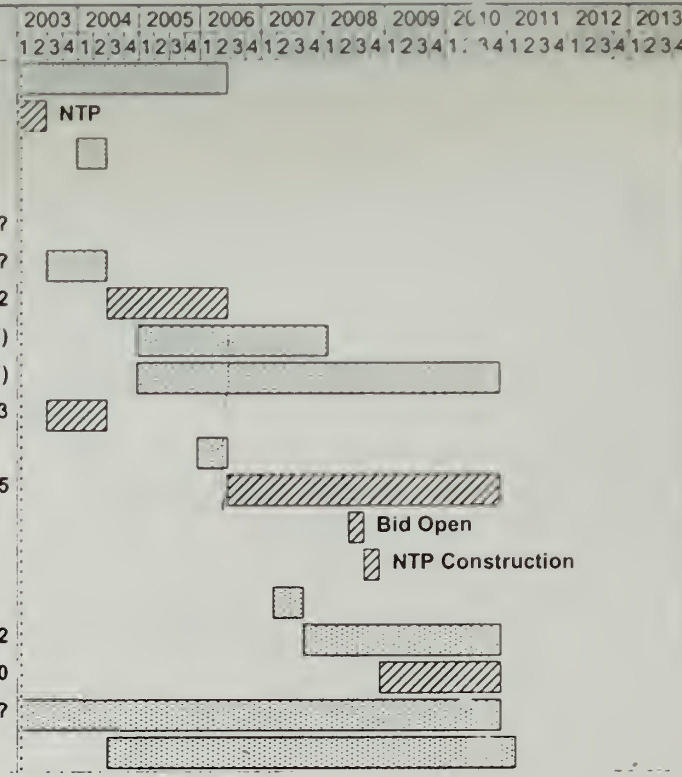


Figure 1
Calaveras Dam Repair/Replacement (Same Storage)
Project Schedule (Version 1): Sequential Engineering & Environmental Review

Task | Summary | Milestone | Critical

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ID No.	Phase	Est. Duration	Est. Cost ($ million)
1	Planning (SFPUC)	30 mons	
2	Conceptual Engineering Consultant Selection	6 mons	
3	Environmental Consultant Selection	6 mons	
4	CIP Programmatic Environmental Documentation [not used]	0 mons	
5	Habitat Conservation Plan (HCP) [not used]	0 mons	?
6	Environmental Baseline Data Collection	12 mons	?
7	Environmental Documentation & Review	24 mons	$2
8	Environmental Permitting Process	32 mons	(cost included in task 7)
9	Public Participation	66 mons	(cost included in task 7)
10	Conceptual Engineering	12 mons	$3
11	Design Consultant Selection	6 mons	
12	Final Design/ Bid & Contract Documents	54 mons	$5
13	Bid Period	3 mons	
14	Award/ NTP	3 mons	
15	Construction Manager Selection	6 mons	
16	Construction Management	39 mons	$12
17	Construction	24 mons	$80
18	Project Management (SFPUC)	78 mons	?
19	Division of Safety of Dams Review/ Approvals	63 mons	

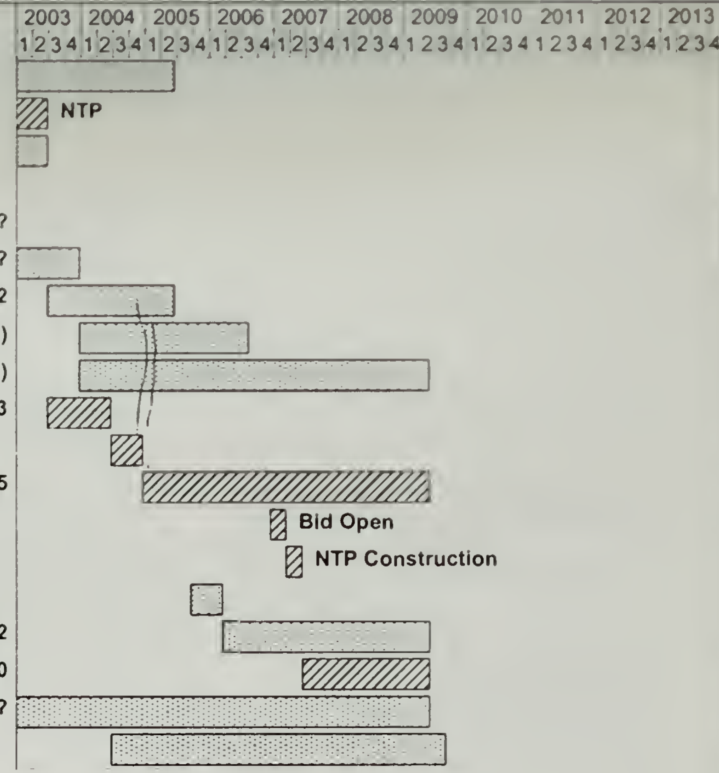

Figure 2
Calaveras Dam Repair/Replacement (Same Storage)
Project Schedule (Version 2): Concurrent Engineering & Environmental Review

Task	Summary
Milestone	Critical

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ID No.	Phase	Est. Duration	Est. Cost ($ million)
1	Planning (SFPUC)	48 mons	
2	Conceptual Engineering Consultant Selection	6 mons	
3	Environmental Consultant Selection	6 mons	
4	CIP Programmatic Environmenal Documentation	18 mons	?
5	Habitat Conservation Plan (HCP) [begins in 2002]	24 mons	?
6	Environmental Baseline Data Collection	18 mons	?
7	Environmental Documentation & Review	24 mons	$3
8	Environmental Permitting Process	41 mons	(cost included in task 7)
9	Public Participation	87 mons	(cost included in task 7)
10	Conceptual Engineering	18 mons	$4
11	Design Consultant Selection	6 mons	
12	Final Design/ Bid & Contract Documents	69 mons	$5
13	Bid Period	3 mons	
14	Award/ NTP	3 mons	
15	Construction Manager Selection	6 mons	
16	Construction Management	52 mons	$18
17	Construction	36 mons	$260
18	Project Management (SFPUC)	117 mons	?
19	Division of Safety of Dams Review/ Approvals	96 mons	

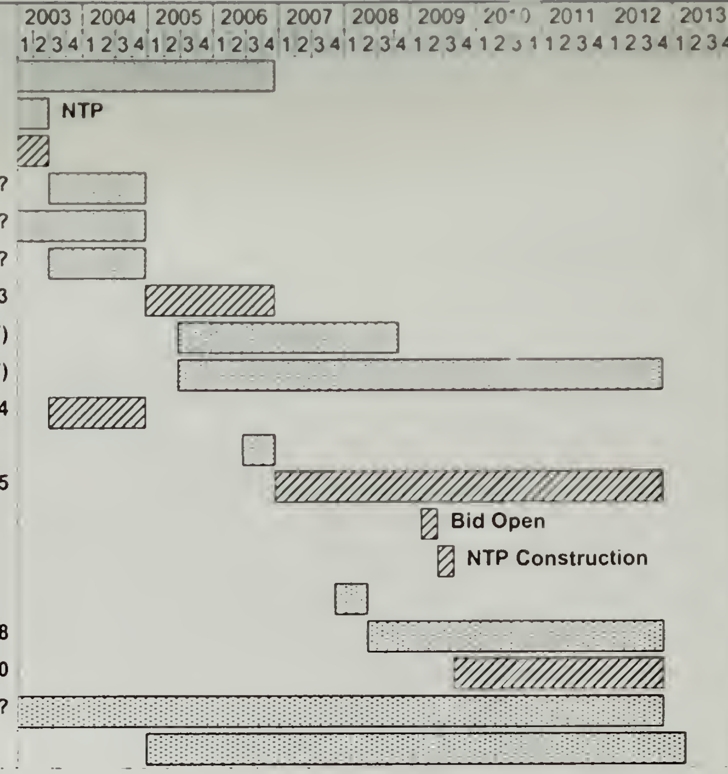

Figure 3
Calaveras Dam Enlargement
Project Schedule (Version 1): Sequential Engineering & Environmental Review

Task | Summary | Milestone | Critical

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ID No.	Phase	Est. Duration	Est. Cost ($ million)
1	Planning (SFPUC)	48 mons	
2	Conceptual Engineering Consultant Selection	6 mons	
3	Environmental Consultant Selection	6 mons	
4	CIP Programmatic Environmenal Documentation	18 mons	?
5	Habitat Conservation Plan (HCP) [begins in 2002]	24 mons	?
6	Environmental Baseline Data Collection	18 mons	?
7	Environmental Documentation & Review	24 mons	$3
8	Environmental Permitting Process	27 mons	(cost included in task 7)
9	Public Participation	85 mons	(cost included in task 7)
10	Conceptual Engineering	18 mons	$4
11	Design Consultant Selection	6 mons	
12	Final Design/ Bid & Contract Documents	69 mons	$5
13	Bid Period	3 mons	
14	Award/ NTP	3 mons	
15	Construction Manager Selection	6 mons	
16	Construction Management	52 mons	$18
17	Construction	36 mons	$260
18	Project Management (SFPUC)	99 mons	?
19	Division of Safety of Dams Review/ Approvals	78 mons	

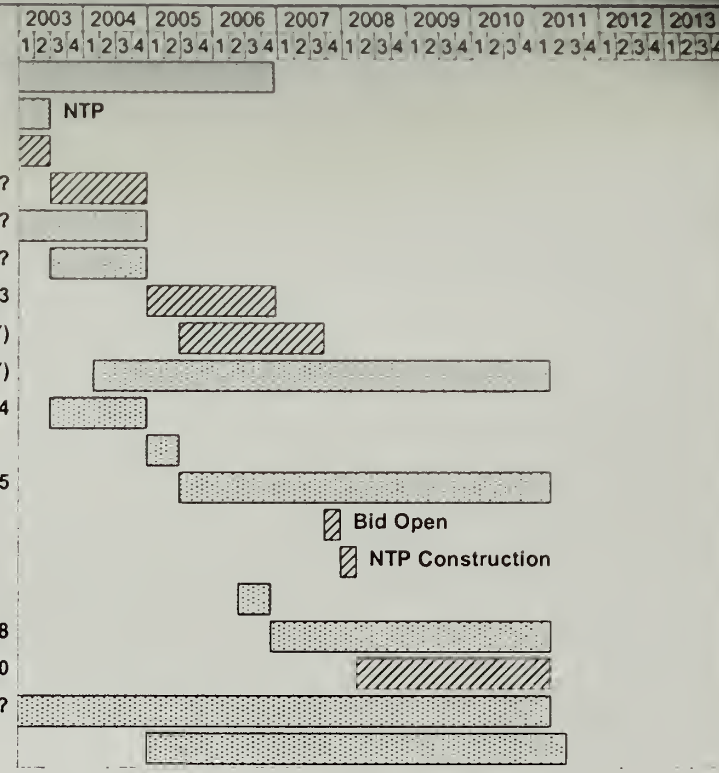
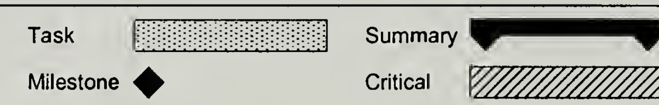


Figure 4
Calaveras Dam Enlargement
Project Schedule (Version 2): Concurrent Engineering & Environmental Review



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